DOCUMENT RESUME

ED 249 226 SP 025 354

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TITLE	Provision of Classroom Instruction That Is Adaptive to Student Differences.
INSTITUTION	Minnesota Univ., Minneapolis. National Support Systems Project.
SPONS AGENCY	Office of Special Education and Rehabilitative Services (ED), Washington, DC. Div. of Personnel Preparation.
PUB DATE	Jun 83
GRANT	OEG007902045
NOTE	194p.; For other modules in this series, see ED 238 844 and SP 025 332-354. For the genesis of these modules, see ED 186 399. Reviewed by Maynard C. Reynolds.
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01/PC08 Plus Postage.
DESCRIPTORS	*Adjustment (to Environment); Classroom Techniques; Curriculum Development; Higher Education; *Individual Differences; *Individualized Instruction; Instructional Materials; Learning Modules; *Mainstreaming; Preservice Teacher Education; Student Needs; *Teacher Education Curriculum; *Teacher Educators
IDENTIFIERS	Education for All Handicapped Children Act

ABSTRACT

This module (part of a series of 24 modules) is on alternative instructional strategies and school resources to be used to provide learning experiences adaptive to the needs and characteristics of individual students. The genesis of these materials is in the 10 "clusters of capabilities," outlined in the paper, "A Common Body of Practice for Teachers: The Challenge of Public Law 94-142 to Teacher Education." These clusters form the proposed core of professional knowledge needed by teachers in the future. The module is to be used by teacher educators to reexamine and enhance their current practice in preparing classroom teachers to work competently and comfortably with children who have a wide range of individual needs. The module includes objectives, scales for assessing the degree to which the identified knowledge and practices are prevalent in an existing teacher education program, and self-assessment test items. Additional readings include a selected bibliography and several articles on adaptive instruction. (JD)

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ED249226

Provision of Classroom Instruction That is Adaptive to Student Differences

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June, 1983

SP 025 354

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Minneapolis, Minnesota

1982

Development. Materials are developed under direction of the National Support Systems Project, University of Minnesota, under the Grant No. referenced above.

Distribution. This resource unit is available as part of a set through The American Association of Colleges for Teacher Education (AACTE), Suite 610, One Dupont Circle, Washington, DC 20036. For individual copies, contact Special Education Programs, 259 Burton Hall, University of Minnesota, Minneapolis, MN 55455. For information on costs and availability, please contact the appropriate office.

Extending the Challenge: Working Toward a Common Body of Practice for Teachers

Concerned educators have always wrestled with issues of excellence and professional development. It is argued, in the paper "A Common Body of Practice for Teachers: The Challenge of Public Law 94-142 to Teacher Education,"* that the Education for All Handicapped Children Act of 1975 provides the necessary impetus for a concerted reexamination of teacher education. Further, it is argued that this reexamination should enhance the process of establishing a body of knowledge common to the members of the teaching profession. The paper continues, then, by outlining clusters of capabilities that may be included in the common body of knowledge. These clusters of capabilities provide the basis for the following materials.

The materials are oriented toward assessment and development. First, the various components, rating scales, self-assessments, sets of objectives, and respective rationale and knowledge bases are designed to enable teacher educators to assess current practice relative to the knowledge, skills, and commitments outlined in the aforementioned paper. The assessment is conducted not necessarily to determine the worthiness of a program or practice, but rather to reexamine current practice in order to articulate essential common elements of teacher education. In effect then, the "challenge" paper and the ensuing materials incite further discussion regarding a common body of practice for teachers.

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*Published by the American Association of Colleges for Teacher Education, Washington, D. C., 1980 ($5.50).

Second and closely aligned to assessment is the developmental perspective offered by these materials. The assessment process allows the user to view current practice on a developmental continuum. Therefore, desired or more appropriate practice is readily identifiable. On another, perhaps more important dimension, the "challenge" paper and these materials focus discussion on pre-service teacher education. In making decisions regarding a common body of practice it is essential that specific knowledge, skill and commitment be acquired at the pre-service level. It is also essential that other additional specific knowledge, skill, and commitment be acquired as a teacher is inducted into the profession and matures with years of experience. Differentiating among these levels of professional development is paramount. These materials can be used in forums in which focused discussion will explicate better the necessary elements of pre-service teacher education. This explication will then allow more productive discourse on the necessary capabilities of beginning teachers and the necessary capabilities of experienced teachers.

In brief, this work is an effort to capitalize on the creative ferment of the teaching profession in striving toward excellence and professional development. The work is to be viewed as evolutionary and formative. Contributions from our colleagues are heartily welcomed.

This paper presents one module in a series of resource materials which are designed for use by teacher educators. The genesis of these materials is in the ten "clusters of capabilities," outlined in the paper, "A Common Body of Practice for Teachers: The Challenge of Public Law 94-142 to Teacher Education," which form the proposed core of professional knowledge needed by professional teachers who will practice in the world of tomorrow. The resource materials are to be used by teacher educators to reexamine and enhance their current practice in preparing classroom teachers to work competently and comfortably with children who have a wide range of individual needs. Each module provides further elaboration of a specified "cluster of capabilities" - in this case, provision of classroom instruction that is adaptive to student differences.

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OVERVIEW OF THE MODULE

Providing educational opportunities and learning experiences that are responsive to the individual needs of students in regular classroom settings is the major objective of the "least restrictive environment" mandate of Public Law 94-142. Implementation of this mandate is resulting in an increasingly heterogeneous student population in regular classrooms. As the range of student differences found in regular classrooms grows, so does the need for teachers to be able to provide instruction that effectively accommodates the diverse needs of their students. The development of such teacher expertise, however, has posed a major challenge to educational professionals in general, and teacher educators in particular. Because adaptive instruction differs in several fundamental ways from the traditional group-based instruction which most pre-service teachers have known in their own schooling, major changes are required in their conceptual perspectives of classroom practices. For these changes to occur, teacher educators must be able to provide not only information on the "how" of adaptive instruction but also a basic understanding of the "why." This module aims to furnish faculty members of colleges of education with information to further their students' understanding of the provision of adaptive instruction in regular classroom settings, the theoretical underpinnings of this instructional approach, and the research evidence related to the implementation and effects of adaptive instruction.

This module contains three major sections. Section I--Objectives, Needs Assessment, and Self-Assessment--includes information designed to help users systematically assess the usefulness of this module in meeting their own professional development needs and the needs of their respective teacher education programs. Specifically, it includes a list of the objectives of the module, a description of reasonable objectives for the users' teacher education programs, a rating scale designed as a needs assessment instrument for determining the extent to which the content covered in this module is already incorporated in the users' teacher education programs, and a self-assessment instrument designed to help the module users evaluate their knowledge and understanding of providing adaptive instruction in classroom settings.

Section II--Provision of Adaptive Instruction--comprises the core content of the module. Five segments, each of which is designed to provide a different perspective on adaptive instruction, present (a) a review of relevant theory, research, and practice; (b) a description of a conceptual model of program design, implementation, and evaluation; (c) an explication of issues related to program evaluation; (d) information on the design of appropriate personnel preparation programs; and (e) a discussion of implications for future developments in personnel preparation.

Section III--Additional Readings on Adaptive Instruction--is designed for users who desire further information. It includes a selected bibliography on adaptive instruction and copies of several articles that are considered to be particularly relevant to the topics discussed in this module.

It should be pointed out that because this module aims to provide concrete examples of specific technical know-how involved in the operationalization of adaptive instruction, many examples and supporting research were drawn from a particular adaptive instruction program that has a relatively long history and a data base supporting its utility and practicability. However, it is important to note that the use of specific examples is not meant to imply either exclusivity or the superiority of this particular adaptive instruction program over others. Rather, it is hoped that teacher educators and teachers-in-training can use the examples cited here as a springboard for discussing and generating approaches and strategies for providing adaptive instruction beyond those described in this module. Other related modules in this series, for example, also have much to offer in providing specific information on adaptive instruction and should be considered components of any comprehensive program for training pre-service teachers. The following is a list of the related modules.

Curriculum-Based Assessment and Evaluation Procedures

Individualized Teaching: Writing Individualized Education Programs

Classroom Strategies for Accommodating Exceptional Learners

Acknowledgment

The author extends her sincere appreciation to Patricia Gennari, Charlie Lakin, and Maynard Reynolds for their suggestions and comments on initial drafts of this work and to Rita Catalano and Erika Gromoll for their editorial assistance in the preparation of this module.

The research reported herein was supported by the Learning Research and Development Center, supported in part as a research and development center by funds from the National Institute of Education (NIE), United States Department of Education. The opinions expressed do not necessarily reflect the position or policy of NIE, and no official endorsement should be inferred.

SECTION I
OBJECTIVES, NEEDS ASSESSMENT, AND SELF-ASSESSMENT

Objectives

Upon completion of this module, you will be prepared to do the following:

1. Provide a working definition of adaptive instruction and describe the unique features of a number of widely used extant adaptive instruction programs and practices.

2. Discuss the implications of adaptive instruction for effective mainstreaming of exceptional students.

3. Identify and describe the major components of a conceptual model of adaptive instruction.

4. Identify and describe program design features, or dimensions, which are considered critical for the effective implementation of adaptive instruction in school settings.

5. Assess the practicality and validity of using a data-based approach to tailor personnel development programs to the training needs of individual in-service and pre-service teachers.

6. Discuss the design and measurement issues related to documentation and evaluation of the implementation and effects of adaptive instruction.

7. Identify and discuss teacher expertise required for effective implementation of adaptive instruction.

8. Identify and discuss the organizational and management supports necessary for effective implementation of adaptive instruction.

Reasonable Objectives for Teacher Education

Teachers-in-training need working knowledge and practical skills in:

1. understanding and appreciating the need for providing instruction that is adaptive to student differences
2. providing adaptive instruction in classroom settings, including
    a. implementing the critical program dimensions of adaptive instruction, and
    b. using degree of implementation assessment procedures for self-assessment and monitoring of program implementation.

Rating Scale for the Teacher Preparation Program

Check the statement that best describes the adequacy of coverage in your present teacher education program on the topic of adaptive instruction.

___ 1. Teachers-in-training are aware of the conceptual and implementation issues related to the general topic of individual differences and the need to accommodate those differences, but no systems approaches are introduced.

___ 2. Teachers-in-training are well-versed in the need for attending to individual differences in students and the design of school learning environments that are responsive to those differences, but little or no practical direction is given to systematic provision of adaptive instruction in classroom settings.

___ 3. Teachers-in-training are familiar with the extant programs of adaptive instruction, but have neither observed nor had practicum experience in classrooms using adaptive instruction.

___ 4. Teachers-in-training have systematic training in implementing critical dimensions of adaptive instruction and have observed and/or had practicum experience in the operation of adaptive instruction programs.

___ 5. Teachers-in-training have working knowledge about one or more extant programs of adaptive instruction and have demonstrated skills in teaching within such a system as part of their practicums.

Self-Assessment

The following items are intended to assess your understanding of adaptive instruction. Respond to short-answer items 1-9 on a separate sheet of paper.

1. Define "adaptive instruction."

2. Briefly describe unique features of two extant programs of adaptive instruction that have been widely implemented in school settings.

3. Discuss major implications of the provision of adaptive instruction for effective implementation of Public Law 94-142.

4. Describe program design features that are critical for effective mainstreaming of exceptional students in regular classrooms.

5. Identify and briefly describe the major components of a conceptual model of adaptive instruction.

6. Discuss the design and research supports for program dimensions that have been identified as critical for supporting effective implementation of adaptive instruction at the classroom level.

7. Discuss the implications of recent technological advances and policy mandates for pre-service training programs.

8. Define interactive instructional decision making and discuss its implications for designing and implementing adaptive instruction programs.

9. Discuss the theoretical and pedagogical rationales for using a data-based approach to training.

In front of the next eight items, place a "T" if you think the statement is true, or an "F" if you think the statement is false.

___ 10. Adaptive instruction is synonymous with open education.

___ 11. Group-based direct instruction is not generally considered an alternative strategy for adaptive instruction programs.

___ 12. Pre-service and in-service personnel preparation should be designed to be adaptive to the needs and talents of individuals-in-training.

___ 13. Data on degree of program implementation are most useful for training purposes and should not be used for program evaluation purposes.

___ 14. Effective teachers make instructional decisions concerning individual students both prior to and during the actual instructional-learning process.

___ 15. Successful implementation of adaptive instruction in multi-age grouped or ungraded classrooms is very unlikely because of the problems associated with the wide range of individual differences represented in such classrooms.

___ 16. Instructional teaming facilitates flexible and effective use of instructional resources such as teacher time and talents.

___ 17. It is not advisable to encourage parents to become actively involved with their child's learning because their involvement may interfere with what teachers are doing in the classroom.

The following numbered items are descriptions of critical program dimensions of adaptive instruction. Match each dimension with the appropriate program design feature in the right-hand column by placing the appropriate letter in the parentheses.

18. Learning materials related to each objective included in the learning sequence of the various curricula are developed and updated. ( )

19. Students' progress through each curricular area and their completed prescriptive tasks are recorded daily. ( )

20. All students are assessed when they enter a new unit of instruction in the curricular hierarchy and when they begin or complete a new curricular objective. ( )

a. Integrated diagnostic-prescriptive process.

b. Systematic provision of a wide range of instructional-learning options.

c. Instructional-learning management system.

21. Each student has his or her own assignment. Included in the assignment is explicit information regarding the learning tasks (e.g., number of tasks or workbook pages to be completed, titles of reference books to be read). (   )

22. Teachers evaluate student learning on an ongoing basis to identify learning difficulties before they become established problems. (   )

23. Teachers move about in all areas of the classroom, responding to student requests or initiating contacts with students for a variety of instructional and management purposes. (   )

24. New tasks and review lessons are presented in small groups, individually, and/or for the whole class. A variety of techniques that have been shown to be effective are identified for use according to subject content and student differences. (   )

25. Teachers use a variety of techniques to help students take on increased responsibility for their learning and behaviors. (   )

Circle the best response(s) listed under each statement.

26. An adaptive instruction program is one which:
    a. is synonymous with the open education approach.
    b. is the direct opposite of the group-based direct instruction approach.
    c. provides alternative instruction to meet the diverse learning needs of individual students.
    d. paces instruction according to the majority of ability levels of individual students in a group.

27. When an adaptive instruction approach is effectively implemented, it is expected that:
    a. each student will differ in his or her placement and rate of progress through the curriculum.
    b. most students will make similar gains as they progress through the curriculum.
    c. all students experiencing difficulty will be placed in special resource rooms.
    d. each student will be more precisely labeled according to his or her learning disability.

28. A major objective of adaptive instruction is to develop each student's competence in academic, social, and self-management skills. Consequently, a program design focus is to enable students to:

    a. work independently in individual settings.
    b. work collaboratively in group settings.
    c. assume increasing responsibility for their own learning and behaviors.
    d. all of the above.

29. When an adaptive instruction program is adopted, classroom processes are likely to look very different from those observed in conventional classrooms. For example, in adaptive instruction classrooms:

    a. students can be observed working at many different tasks at different levels.
    b. students can be observed working in groups and individually.
    c. the teacher's desk is centrally located and students are expected to approach the teacher for instruction and feedback.
    d. the teacher moves around the room, diagnosing, instructing, monitoring, and evaluating students.
    e. students are expected to take responsibility for their own learning and complete all tasks within a specified time limit.
    f. it is the teacher's responsibility to assign all students' tasks and to specify the time limit for completion of the tasks.

g. it is expected that the teacher will spend increased amounts of time instructing, and less time managing students.

h. it is expected that all behavioral problems will be handled by an aide, allowing the teacher increased amounts of instructional time.

i. students' independent movement around the classroom is regulated by an explicit management system.

Answer Key

1. Define "adaptive instruction."

Adaptive instruction is an educational approach aimed at accommodating the individual differences of each student. Toward this end, adaptive instruction utilizes a variety of instructional methods and provides learning experiences that are responsive to the individual characteristics and learning needs of students, as well as explicit interventions that increase students' competence and enhance their capability to profit from available educational alternatives.

2. Briefly describe unique features of two extant programs of adaptive instruction that have been widely implemented in school settings.

3. Discuss major implications of the provision of adaptive instruction for effective implementation of Public Law 94-142.

One of the effects of Public Law 94-142 has been decreased enrollments in segregated special education facilities which, in turn, have resulted in an increased need to expand the capacity of regular classrooms and related support systems to accommodate exceptional students. Thus, educational systems that adapt instruction to the increasingly diverse needs of students mainstreamed in regular classes must be established.

4. Describe program design features that are critical for effective mainstreaming of exceptional students in regular classrooms.

-- A comprehensive individualized instructional system that adapts to the needs of individual students.

-- A built-in support system that facilitates implementation of the instructional program through the involvement of school administrative and instructional support personnel, health professionals, and families.

-- Use of a "full-time" rather than a "shared-time" approach to providing for the special education needs of regular and exceptional students.

5. Identify and briefly describe the major components of a conceptual model of adaptive instruction.

Program design which begins with the identification of instructional goals and description of student characteristics. This information constitutes basic input in the design of those program dimensions that are critical for the ongoing provision of adaptive instruction in classroom settings as well as those dimensions related to the provision of classroom-level and school-/district-level supports for program implementation.

Program implementation which provides the systematic framework for analyzing the implementation needs for the operationalization of adaptive instruction in a specific school setting. Decision making regarding the adoption and operation of a given adaptive instruction program, as well as continuing improvement and refinement of program implementation, is facilitated by information on the program's operation and the degree to which its major features are implemented. Information on program implementation is critical in assessing program efficacy and for linking program effects and key program features.

Program evaluation which provides the data base for analysis and documentation of both the process and product outcomes of adaptive instruction. Program outcomes are evaluated in relation to the extent to which the degree of implementation results in specific desirable classroom processes and, subsequently, the achievement of social and academic competence by students. The resulting data base is used for program refinement, program evaluation, and policy making purposes.

6. Discuss the design and research supports for program dimensions that have been identified as critical for supporting effective implementation of adaptive instruction at the classroom level.

Arranging Space and Facilities fosters students' independence and responsibility for managing their own learning behaviors by arranging furniture and equipment to facilitate easy movement; organizing learning materials and storage and display areas to permit independent selection and replacement of materials by students; and explicitly controlling for the number of students in each activity area as well as the movement between activity areas.

Establishing and Communicating Rules and Procedures fosters students' independence in managing their learning environment and activities by clearly defining rules and procedures governing use and maintenance of instructional materials, scheduling of activities, work completion, and independent movement about the room.

Managing Aides provides the opportunity for teachers and their aides to discuss the performance, behavior, and achievement of individual students and to design instructional plans and specify assignments in accordance with each student's needs.

Developing Student Self-Responsibility for planning and managing their own learning and behaviors is accomplished by teaching students to locate and return all materials needed to carry out tasks, to focus on learning tasks or constructive peer interactions while awaiting teacher assistance, to make activity choices and scheduling decisions, and to monitor and evaluate their own progress.

7. Discuss the implications of recent technological advances and policy mandates for pre-service training programs.

Two recent developments have implications for pre-service training programs. These developments are policy mandates determining current school improvement needs and the technological advances and expanding knowledge base on the theories of learning and instruction and improved educational practices. As a result of these contextual and substantive developments, significant changes are occurring in the expectations and role definitions of educational professionals and in the availability and scope of personnel preparation and continuing professional development programs.

Policy Mandates

Public sentiment, economic realities, and recent Federal and state legislation have created mandates for school change. Schools, in response to these challenges, have been faced with the charge of identifying and implementing innovative programs aimed at better serving the diverse learning needs of children and young adults of all races, language groups, social classes, and educational characteristics. However, educational improvement requires more than just the availability of workable and effective programs. Too often, those responsible for operationalizing innovations encounter great difficulty in the adoption and implementation of valuable ideas, programs, and products because of inadequate training. Moreover, the increased pressure for innovative school improvement efforts has been accompanied by declining enrollments and dwindling Federal subsidies. The result typically has been cutbacks in the hiring of additional staff. Thus, greater public demand for improved educational services, combined with reduced staffing resources, has served to intensify the pressure on school personnel who are often criticized quite vocally for the quality of education they provide.

School personnel look to those responsible for personnel preparation in colleges of education to develop alternative ways to improve the skills and capabilities of in-service and pre-service personnel. The "least restrictive environment" mandate of Public Law 94-142, for example, challenges schools to implement innovative practices such as mainstreaming. Accomplishment of this objective, however, requires the provision of ongoing professional training to support the establishment and maintenance of such innovations. Colleges of education, therefore, are pressured to redirect their training of educational personnel to focus on instructional methods that are adaptive to the special needs of individual students in regular classrooms.

Technological Advances

Recent developments in research on effective teaching and cognitive instructional psychology have provided a substantive base for improving the knowledge and skills of school personnel for implementing adaptive instruction programs. Some of these developments are in the areas of cognition and educational productivity and instructional decision making and interactive teaching.

Psychologists' renewed interest in cognition has resulted in research related to the understanding of human learning and schooling management. One such example is the research on cognition and educational productivity. Findings on the limiting factors in most human activities, such as bounded rationality and the scarcity of attention and time, have great implications for furthering understanding of teachers' mastery of a complex system of adaptive instruction and the ways to promote teaching expertise and productivity. These findings have come into play, for example, in the planning and implementation of instruction as well as in the identification of those substantive and psychological factors that influence effective processing of the wide array of information involved in adapting instruction to differences among individual students. Adaptive instruction requires ongoing processing of information on each student's learning history and current performance (student cues) as teachers evaluate, and make alternative plans to facilitate, the student's mastery of learning objectives. Teachers must make instructional decisions based not only on student cues, but also on information about the availability of alternative strategies and materials as well as the nature of the tasks to be learned. Furthermore, the ways in which such information is put to use in the provision of adaptive instruction also are influenced by each teacher's personal beliefs about education and about the potential effectiveness of particular strategies with specific students. Thus, it is clear that the immense cognitive complexity teachers face in implementing adaptive instruction in classroom settings must be addressed in pre-service training programs.

8. Define interactive instructional decision making and discuss its implications for designing and implementing adaptive instruction programs.

Interactive instructional decision making is ongoing, usually occurs during class time, and is often based on the immediate student performance cues that teachers receive during the instructional-learning process. This type of decision making provides a way for teachers to effectively attend to students' changing needs. Interactive instructional decisions involve the use of instructional interventions such as directing or redirecting students' attention to a task, providing feedback to students, and determining the source of students' errors and providing explanations and/or additional instruction.

9. Discuss the theoretical and pedagogical rationales for using a data-based approach to training.

Teachers learn in different ways and come to their jobs at different stages of development. A data-based approach to training can be adapted to the identified strengths and weaknesses of individuals rather than those of the group at large. The data-based approach also provides a system for self-monitoring of program implementation and ensuring program maintenance by individual staff members.

10. F
11. F
12. T
13. F
14. T
15. F
16. T
17. F
18. b
19. a

20. a
21. a
22. a
23. c
24. b
25. c
26. c
27. a
28. d
29. a, b, d, e, g, i

SECTION II
PROVISION OF ADAPTIVE INSTRUCTION

Introduction

Throughout the history of formal schooling, educators have been interested in the use of alternative instructional strategies and school resources to provide learning experiences that are adaptive to the needs and characteristics of individual students. In this country, the decade of the 1920's was marked by special emphasis on individualized instruction. The 1925 yearbook of the National Society for the Study of Education, entitled Adapting the Schools to Individual Differences, includes descriptions of several programs of individualized instruction such as Burk's Individual System, the Winnetka Plan, the Dalton Plan, and many others (Washburne, 1925). This early foundation for the theory and practice of adaptive instruction provided substantial and growing impetus for the development and study of educational programs and instructional technologies that increase schools' capabilities to accommodate diverse student abilities, experiences, interests, and socioeconomic backgrounds.

Individualized instruction, particularly during the past decade, has come to be associated with school improvement efforts aimed at ensuring equal and quality educational opportunities for each and every school-aged child and young adult (e.g., Consilio, 1974; Gordon, 1979; Reynolds & Wang, 1981; Wang, 1980a). This focus stems, in part, from technical advances in the development of relevant theories and demonstrably effective adaptive instruction practices (Glaser, 1977; Henry, 1962; Snow, 1977; Wang & Lindvall, in preparation; Weisberger, 1977), as well as from public, judicial, and legislative movements (Reynolds & Wang, 1981, Wang, 1981a; Wendel, 1977). Whatever the reason, many school districts attempt to assess individual capabilities and utilize their varying curricular materials to match instruction, as directly as possible, to those capabilities. While there appears to be growing receptivity to instructional approaches that are tied to the direct assessment of each student's capabilities and the building of each student's competence, implementation of such practices in schools has been scanty. A major stumbling block has been the lack of training support for school personnel as they take on the responsibility of such school change efforts.

The goal of this module is to contribute to the information base necessary for developing the kind of training supports required to effectively implement adaptive instruction. This section of the module was developed to accomplish three goals: to summarize the state of the art of research and development aimed at provision of schooling experiences that are adaptive to student differences, to explicate a conceptual model of adaptive instruction that provides a framework for developing the knowledge base and competencies necessary for effective adaptive classroom instruction, and to present an alternative approach to pre-service and in-service training in the context of current school improvement needs and the provision of adaptive instruction. The specific topics covered under each of the three goals are listed below.

1. To provide an overview of past and current theories, research, and practice related to adaptive instruction.
    a. Basic assumptions of adaptive instruction.
    b. Recent theoretical and technological advances related to adaptive instruction.

   c. Selected widely used systems for individualized instruction.
   d. Implications of Public Law 94-142 as they relate to the implementation of adaptive instruction.

2. To provide a conceptual basis for the development and implementation of adaptive instruction in classroom settings.
   a. Rationale and design of critical program design dimensions required to establish and maintain a system for providing adaptive classroom instruction.
   b. Methodological and procedural issues related to evaluation of adaptive instruction.
   c. Illustrations of the kinds of information needed to assess the presence and absence of critical program design dimensions and desired outcomes.

3. To address teacher development needs and to present an alternative training approach for the provision of adaptive instruction.
   a. Recent advances in effective schooling research and cognitive psychology and how these advances affect teacher education programs.
   b. An alternative training approach that is individually tailored and school-based.

Theory and Practice of Adaptive Instruction

Some Basic Assumptions

The concept of maximizing learning through the provision of adaptive instruction is based on the assumption that students learn in different ways and at different rates. Furthermore, it is believed that accommodating these differences requires not only a variety of instructional methods and learning experiences that are matched to individual characteristics, talents, interests, and past performance, but also explicit interventions that increase each student's competence and enhance his or her capability to profit from available educational alternatives. Thus, the term "adaptive" refers to modification of school learning environments in accordance with student differences, as well as modification of the individual student's ability to learn successfully in such environments (Glaser, 1977).

As with many innovative concepts and terminologies, the general perceptions and operational definitions of adaptive instruction have varied. In light of the somewhat conflicting and often inaccurate characterizations that have been put forth, several distinctions should be noted. First, contrary to frequent portrayals in the recent literature on effective teaching, adaptive instruction is not in diametric opposition to the continuum of various conventional educational approaches that include group-based direct instruction (e.g., Brophy, 1979; Rosenshine, 1976). Nor is it synonymous with open education or other student-centered instructional approaches (e.g., Peterson, 1979). Rather, adaptive instruction is an educational approach aimed at providing learning experiences that effectively help each student achieve desired educational goals. As such, its operationalization incorporates a wide range of alternative techniques and practices that are likely to include many of those associated with direct instruction and/or learner controlled instruction. In fact, the adoption of instructional alternatives (e.g., teacher-directed lessons in groups or with individual students, student-initiated exploratory activities, individual and/or group projects) is a key feature in the design of adaptive instruction programs.

A second notable distinction of adaptive instruction is its non-exclusiveness in terms of the types of settings in which instruction and learning occur. Although the provision of adaptive instruction requires individualized planning, each student's educational plan need not be, and in most cases should not be, carried out entirely on an individual basis. Even in the most highly individualized instructional programs, educational objectives related to oral communication and social cooperation, for example, require instruction in group settings. Thus, the inclusion of group lessons is assumed, both from the viewpoint of effective instructional management and in keeping with the pedagogical requirements for meeting a certain set of objectives. Adaptive instruction does not necessarily mean that students work entirely alone; nor does it mean teaching that is unstructured or not "active."

Theoretical and Technical Advances

Great strides have been made during the past several decades in the development of theories and practices of adaptive instruction. These advances have greatly increased the knowledge base on instructional design technologies and the practical know-how required to provide school learning environments that effectively accommodate a wide range of student differences. Two major developments have been in the conceptualization of individual differences and effective schooling and in the operationalization of adaptive instruction in schools.

Conceptualization of individual differences. The basic notion that students differ as individuals, particularly in terms of their level of achievement and their manner and rate of learning, has been widely accepted for quite some time. However, a gradual change has occurred in the nature and interpretation of information related to learning differences. Individual differences in learning no longer are considered to be "static." As pointed out by Bloom (1981), they can be altered either before the instructional-learning process begins or as part of the process. This change in the view of individual differences has had profound implications for instruction during the last two decades. Rather than being seen as the result of differences in learning characteristics and basic capabilities, students' success or failure in school has come to be recognized as a function of the learning environment and, therefore, the responsibility of the schools.

In his discussion of the contrasts between the predominant approach of the selective education mode and the adaptive education mode, Glaser (1977) has suggested that individual differences in students traditionally were accepted as "givens," serving as a basis for classifying groups of students and differentially predicting their probable future achievement. The selective mode has come to be displaced, however, by the view of individual differences as the basis for effective instructional planning. Thus, the operational goal of effective schooling, in this context, is the provision of educational experiences that either are adjusted to students' current levels of functioning or are designed to alter their functioning through the use of special instructional and learning processes to successfully teach prerequisite skills.

In addition to, or perhaps because of, changes in how individual differences in learning are viewed, as well as recent developments in cognitive psychology and information process research, there has been a major shift in the kinds of information which are examined in investigations of individual differences. Instead of characterizing a student's learning by measures of outcome or input differences, the focus has shifted to analyzing those processes that are intrinsic to competent performance. Increasing research evidence suggests that there is a wide range of variability in the psychological processes used by individuals to mediate the acquisition, organization, retention, and generation of knowledge and skills (e.g., Anderson, Spiro, & Montague, 1977; Glaser, 1972; Klahr, 1976; Newell & Simon, 1972; Resnick, 1976; Sternberg, 1979). Furthermore, these variations may be attributed to the adoption by students of particular learning processes that they perceive to be pertinent to the task at hand. Thus, instead of characterizing individual differences in terms of general abilities and aptitudes, learner differences are increasingly characterized in terms of the manner in which information is processed, the mental mechanics and rules that students bring to the instructional environment, and the knowledge and competence of individual students (Glaser, 1976; Scandura, 1977). These and other developments have resulted in major changes in the nature of the research questions and paradigms used in investigations of hierarchical differences in learning. Findings from studies regarding the intervening cognitive processes used in skilled performance have important ramifications for the planning of instructional treatments that are adaptive to functional differences in students.

Operationalization of adaptive instruction in schools. The rather sharp increase in Federal funding for educational research and development during the 1960's and 1970's stimulated extensive development and implementation of innovative school programs. This period of increased interest coincided with the popularity of the "ungraded school" and the "open classroom," both of which include some provisions for individualization. Among the widely known research-based individualized programs are Individually Guided Education--IGE (Klausmeier, 1972); Individually Prescribed Instruction--IPI (Lindvall & Bolvin, 1967); Mastery Learning (Bloom, 1968); and the Program for Learning in Accordance with Needs--PLAN (Flanagan, 1967). These programs, which owe much to earlier efforts such as the Winnetka Plan and similar programs developed in the 1920's, have provided a substantial data base for demonstrating the feasibility of providing adaptive instruction in regular school settings (Talmage, 1975; Wang & Walberg, in preparation; Weisberger, 1977).

Selected Model Programs

Several widely adopted current programs of adaptive instruction are briefly described below for illustrative purposes. They by no means represent an exhaustive list. Rather, the purpose is to draw attention to the different types of school programs that currently are implemented. More detailed discussions of the design and efficacy of the programs can be found in documents cited in this module and elsewhere (e.g., Wang & Walberg, 1983a).

Adaptive Learning Environments Model (ALEM). The ALEM is the product of a decade of research and development at the University of Pittsburgh's Learning Research and Development Center (Wang, 1980a). The objectives of the program are to foster students' successful acquisition of basic academic skills and, simultaneously, to develop students' confidence in their ability to learn and to cope with the social and intellectual demands of schooling. Toward this end, the ALEM's design uses prescriptive instruction based on a wide variety of skills mastery techniques in combination with those aspects of informal or open education that generate independent inquiry and social cooperation. The feasibility of wide-scale replication of the ALEM, as well as the evidence of program efficacy, has been reported in a number of documents (e.g., Wang, 1983b, 1983c).

Individually Guided Education (IGE). Developed at the Wisconsin Center for Education Research at the University of Wisconsin-Madison (Klausmeier, 1972), IGE is conceptualized as a comprehensive alternative system of scheduling. It is designed to produce higher educational achievement by effectively providing for differences in students' rates of learning, learning styles, and other characteristics. The program is implemented in elementary and middle school classrooms in a large number of school districts. Thus, there is a considerable evaluation data base to suggest its implementability and efficacy (Klausmeier, 1975; Wang & Walberg, 1983a).

Mastery Learning. This theory of instruction and learning was conceptualized by Benjamin Bloom (1968). It is based on the contention that each student can learn successfully if provided with sufficient help when difficulties are first encountered. Skills mastery is defined clearly in the context of learning units, and adequate time is allowed to achieve mastery. Because it can be assimilated easily into regular classrooms, Mastery Learning forms the basis for a number of programs currently in use (Block, 1971).

Team Assisted Individualization (TAI). Developed at the Johns Hopkins University Center for the Social Organization of Schools, the overall goal of this program is to realize both the social benefits of cooperative learning among students of varying achievement levels and the academic benefits of instruction that is geared to each student's level and rate of learning. This cooperative-individualized approach has been found to be effective in increasing students' achievement, social acceptance, and positive attitudes and behaviors (Slavin, Leavey, & Madden, 1982; Wang & Walberg, 1983a).

Implications of Public Law 94-142

In the years since its passage, the Education for All Handicapped Children Act of 1975 has had pervasive and profound implications. It has come to be viewed as the herald of basic educational reform that extends beyond the parameters of current special education programs. Among the most far-reaching effects have been decreased enrollments in segregated special education facilities (e.g., special classes, day schools, residential schools) and, consequently, an increased need to expand the capacity of regular classrooms and related support systems to accommodate handicapped students.

Two conditions must be created if the principles inherent in Public Law 94-142 are to be applied successfully. The first involves the establishment of educational systems whereby all students receive instruction that is adapted to their individual needs. The second, and perhaps the most important, condition for successful compliance with Public Law 94-142 is the development of a sense of "community" and the desire among educational professionals to undertake reforms as universally sound, yet as operationally difficult, as those required by the "least restrictive environment" mandate.

Provision of adaptive instruction for all students. Several recent developments suggest that the time may be right for a major move toward systematically accommodating differences among all students through the provision of adaptive instruction. Many researchers and practitioners are calling for non-categorical approaches to instruction for mildly handicapped students (Birman, 1979; Hallahan & Kauffman, 1978; Heller, Holtzner, & Messick, 1982; Prouty & McGarry, 1972; Reynolds & Wang, 1981). At least three states (California, Massachusetts, and Vermont) currently have policies which mandate non-categorical approaches, and several others are considering such policies. In addition, as greater numbers of their children spend time in regular classrooms, parents of handicapped students are becoming increasingly more sensitive to the quality of current mainstreaming programs. Minority group parents, who have been very vocal in their objections to special education labeling systems, and whose children are being moved in disproportionate numbers from special education to mainstreaming settings, can be expected to show growing concern over the nature and quality of available programs.

Furthermore, the legal claims for "appropriate" education are spreading beyond handicapped students. Several states now require Individualized Educational Programs (IEP's) for gifted students, and some are considering requiring IEP's for all students. Moreover, many parents of non-handicapped students are aware of the appropriateness of individualized instruction and are demanding quality education for their children in regular classrooms.

Finding ways to more effectively adapt school learning experiences to the individual needs of each student in regular classrooms has become a major focus of current school improvement efforts (National School Public Relations Association, 1981). School administrators and teachers appear to be more responsive than ever to individualized instruction. This is evident from the results of a recent survey which showed the preferences of school personnel for direct assessment of student capabilities and direct instruction that builds each student's competence in basic skills areas (Rothrock, 1982). The underlying premise is that providing learning experiences which meet the needs of exceptional and non-exceptional students in regular classroom settings can result in maximized opportunities for all students to succeed in their school learning. Under instructional programs designed to accommodate individual differences, variations in the placement and learning progress of individual students are expected, and even assumed, by teachers, students, and parents. In such classrooms, no special labeling is needed to differentiate one student from another, and momentary problems in learning are not viewed as failures, but as occasions for further teaching. Consequently, all students should be able to receive instruction that is suited to their needs without the negative effects of special labeling or social and educational segregation.

A transdisciplinary approach to providing educational services. The second basic condition for the provision of effective educational services to every student in the spirit of Public Law 94-142 is the broadened collaboration of all educational professionals. The goal of this collaboration should be to strengthen existing capabilities for addressing student differences with substantive understanding and a disposition of mutual helpfulness. Public Law 94-142 challenges educational professionals to integrate those demonstrably effective instructional alternatives and classroom management systems that presently are implemented independently by special education and regular education programs. Among the major considerations in such broad-scaled educational restructuring are expansion of the role of regular teachers; redefinition of the roles of special education personnel; changes in the functions and work places of other special teachers, speech-language pathologists, and school psychologists; and changes in the roles of school administrators and other educational professionals whose work is tied closely to the education of students with special needs. Thus, use of the term "transdisciplinary," instead of "multidisciplinary," to describe such an approach to providing effective services emphasizes the need to effectively incorporate and interrelate information about all aspects of students' learning and development. Effective interfacing of the work of many specialized professionals and regular classroom teachers, therefore, is seen as fundamental for the provision of adaptive instruction for all students.

It should be noted that widespread implementation of this transdisciplinary approach, whereby adaptive instruction facilitates the full-time integration of exceptional and non-exceptional students, does not eliminate the need for a range of alternatives to accommodate many different handicaps. It would continue to be necessary, for example, to place severely and profoundly handicapped students outside mainstream classes, and to provide a minimum level of pull-out programs (e.g., resource rooms).

A Conceptual Model of Adaptive Instruction

In this section, a conceptual model for the design, implementation, and evaluation of educational programs aimed at providing school learning experiences that are adaptive to student differences is presented. First, an overview of the conceptual model is presented; then, a more detailed explanation is provided of the critical program design dimensions of adaptive instruction and the specific clustering of the dimensions to serve particular functions.

An Overview

Figure 1 is a schematic representation of the model, which is based on the notion that the development of adaptive instruction programs is an iterative process of program design, implementation, evaluation, and refinement. The model, developed from past and current research and development efforts in adaptive instruction, consists of three major components. The first component is program design work (shown by the square and rectangular boxes in Figure 1) that begins with identification of instructional goals and description of student

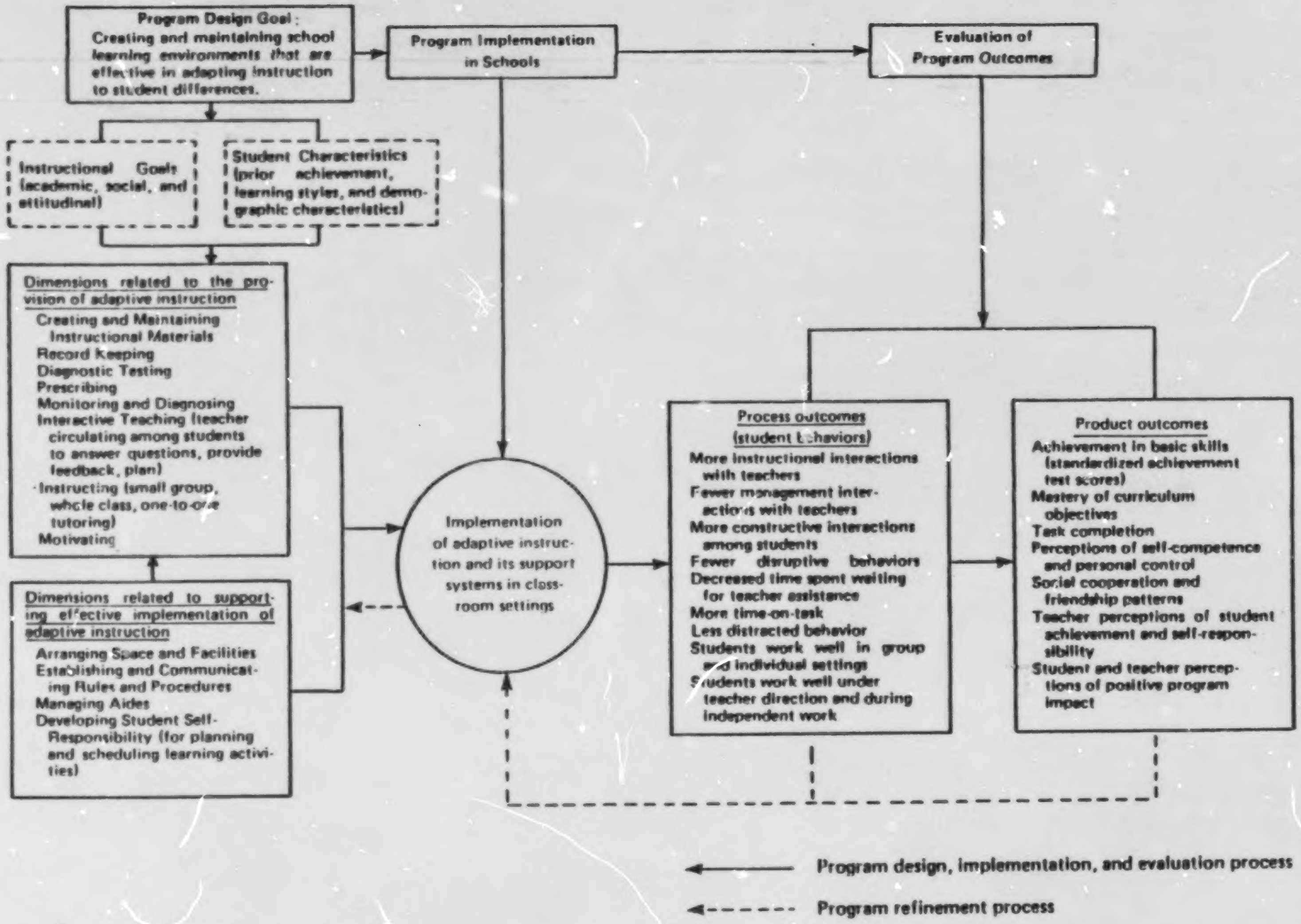
Program Design Goal: Creating and maintaining school learning environments that are effective in adapting instruction to student differences.
Program Implementation in Schools
Evaluation of Program Outcomes
Instructional Goals (academic, social, and attitudinal)
Student Characteristics (prior achievement, learning styles, and demographic characteristics)
Dimensions related to the provision of adaptive instruction
Creating and Maintaining Instructional Materials
Record Keeping
Diagnostic Testing
Prescribing
Monitoring and Diagnosing
Interactive Teaching (teacher circulating among students to answer questions, provide feedback, plan)
Instructing (small group, whole class, one-to-one tutoring)
Motivating
Dimensions related to supporting effective implementation of adaptive instruction
Arranging Space and Facilities
Establishing and Communicating Rules and Procedures
Managing Aides
Developing Student Self-Responsibility (for planning and scheduling learning activities)
Implementation of adaptive instruction and its support systems in classroom settings
Process outcomes (student behaviors)
More instructional interactions with teachers
Fewer management interactions with teachers
More constructive interactions among students
Fewer disruptive behaviors
Decreased time spent waiting for teacher assistance
More time-on-task
Less distracted behavior
Students work well in group and individual settings
Students work well under teacher direction and during independent work
Product outcomes
Achievement in basic skills (standardized achievement test scores)
Mastery of curriculum objectives
Task completion
Perceptions of self-competence and personal control
Social cooperation and friendship patterns
Teacher perceptions of student achievement and self-responsibility
Student and teacher perceptions of positive program impact
Program design, implementation, and evaluation process
Program refinement process

Figure 1. A conceptual model for the design, implementation, and evaluation of an adaptive instruction program.

This figure is taken from Wang, M.C. Provision of adaptive instruction: Implementation and effects (LRDC Publications Series). Pittsburgh, Pa.: University of Pittsburgh, Learning Research and Development Center, 1983.

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characteristics. This information constitutes basic input in the design of those program dimensions that are critical for the ongoing provision of adaptive instruction in classroom settings as well as those dimensions related to the provision of classroom-level and school-/district-level supports for program implementation. The second component of the model is related to program implementation in school settings, and the third component focuses on evaluation of related process and product outcomes.

An unique feature of the model's evaluation component is the explicit inclusion of both product and process measures as indicators of program outcomes. Product outcomes are defined here as the abilities and attitudes acquired by students. These results are determined at specific terminal points in exposure to the program. Examples of product outcomes include achievement in the basic skills and development of perceptions of self-competence and personal control over learning. Process outcomes, on the other hand, are the abilities and attitudes students acquire and display while participating in the program. These results, which are of value because they enhance students' capabilities to profit from their classroom learning experiences, are ongoing. Thus, they can be assessed only while students are functioning in the classroom. Examples of process outcomes include the ability to plan and manage learning activities and the ability and willingness to assist other students. It is assumed that such outcomes are likely to be a continuing part of students' behavior. Therefore, while process outcomes are mediating variables that lead to intended product outcomes, they also are major outcomes of adaptive instruction in their own right.

As suggested by the arrows in Figure 1, program outcomes are evaluated in relation to the presence or absence of critical program dimensions (listed in the column of boxes on the left of Figure 1); the extent to which implementation of the dimensions leads to specific classroom processes that are hypothesized to be characteristic of adaptive instruction (teachers' and students' behaviors); and the extent to which the classroom processes lead to students' social and academic competence. In other words, outcomes are interpreted in relation to the degree of program implementation and the relationship between the degree of implementation and the resulting process and product outcomes. The resulting information can be used to answer the questions, "Does the program produce the predicted process and product outcomes?", and, "How can we do it better?"

Critical Program Dimensions

As already noted, two categories of program design dimensions are included in the conceptual model of adaptive instruction--dimensions related to the provision of adaptive instruction and dimensions related to supporting program implementation. The following sections describe the 16 dimensions, their objectives, and the categories to which they belong.

Program dimensions related to provision of adaptive instruction.

Eight program dimensions have been identified as critical design features for effective provision of adaptive instruction--Creating and Maintaining Instructional Materials, Record Keeping, Diagnostic Testing, Prescribing, Monitoring and Diagnosing, Interactive Teaching, Instructing, and Motivating. The objectives of each dimension are described briefly below.

1. Creating and Maintaining Instructional Materials. Learning materials related to each objective included in the learning sequences of the various curricula are created and maintained. A variety of learning materials is available to allow students a choice, including materials to be used in working alone or in interacting with other students in small groups. Teacher-constructed instructional materials are accompanied by a list of materials needed to carry out each task, the objective the task is designed to teach, directions that are understandable to students, and questions that can be used by teachers in probing and evaluating task performance.

2. Record Keeping. All classroom records are updated daily. Records include wall charts on individual students' progress in the curricular areas and a record of the daily prescriptive tasks completed by each student in each curricular area.

3. Diagnostic Testing. All students are given placement tests when they enter a new unit of instruction in the curricular hierarchy or when teachers feel a reevaluation is necessary. Before starting work on a new curricular objective, each student is given a pretest; upon completion of the objective, a progress check or posttest. Most students pass at least one posttest in each curricular area each month.

4. Prescribing. Each student has his or her own prescription. Diagnostic test results and information from informal observations are used by teachers to prepare prescriptions in accordance with the sequence suggested by the curricular hierarchies. Included in the prescriptions is explicit information regarding assigned learning tasks

(e.g., number of tasks or workbook pages to be completed, titles of reference books to be read, listing of group or individual activities to be performed).

5. Monitoring and Diagnosing. Teachers evaluate student learning on an ongoing basis to identify learning difficulties before they become established problems. They utilize knowledge about the curricular level in which each student is working, as well as information obtained from parents and relevant school staff. Teachers check work in the students' presence and provide feedback. They determine the source of students' difficulties in completing tasks and alter prescriptions accordingly.

6. Interactive Teaching. Teachers continuously move about in all areas of the classroom, either responding to student requests or initiating contacts with students for a variety of instruction and management related purposes. Interactive teaching activities include providing on-the-spot instruction, changing prescriptions based on reassessment of student needs, and giving feedback and reinforcement to students as needed. Each student contact is relatively short in duration. When extended assistance or tutoring is required, sessions are scheduled for a later time. Upon completion of a student contact, teachers scan the room to determine the next teaching task which is chosen by recognizing a student who has requested assistance or by an on-the-spot analysis of student needs.

7. Instructing. Instruction in new tasks and review lessons is provided in small groups, individually, and/or for the whole class. A variety of techniques that have been shown to be effective (e.g., questioning, explaining, cueing or prompting, structuring, restructuring, giving evaluation feedback, demonstrating, modeling) are identified for use according to subject content and student differences.

8. Motivating. Motivation techniques are used to help students take on increased responsibility for their learning and behaviors. Teachers communicate their expectations for students' successes both verbally and non-verbally, and they encourage self-management skills, independence, and peer cooperation. Teachers show personal regard for each student and give praise when appropriate.

Program dimensions related to supporting program implementation. Four program dimensions have been identified as being critical for supporting program implementation at the classroom level. These dimensions are Arranging Space and Facilities, Establishing and Communicating Rules and Procedures, Managing Aides, and Developing Student Self-Responsibility. The objectives of each of these classroom support dimensions are summarized briefly below.

9. Arranging Space and Facilities. The physical space and facilities within the classroom are designed to foster and permit students' independence and responsibility in managing their learning behaviors. Furniture and equipment are arranged to facilitate easy movement between areas; material storage and display areas are accessible to students; learning materials are systematically organized to permit independent selection and replacement by students; and there is an explicit system for controlling the numbers of students in, and the movement between, activity areas.

10. Establishing and Communicating Rules and Procedures. Rules and procedures are made explicit to students to permit independent management of their learning environment and activities. Rules and

procedures are clearly defined for governing the use and maintenance of instructional materials as well as the scheduling of activities, work completion, and independent movement about the room.

11. Managing Aides. Teachers meet with aides (paraprofessionals, classroom volunteers) regularly each day to make plans and specify assignments, as well as to discuss the performance of individual students and specific concerns about student behaviors and achievement.

12. Developing Student Self-Responsibility. Teachers foster the development of students' skills in planning and managing their own learning and behaviors. Students are taught to locate and return all materials and equipment needed to carry out tasks; to clean up their work place; to focus on curricula related learning tasks or constructive peer interactions while waiting for teacher assistance; to carry out assigned tasks with minimum teacher supervision and assistance; to make activity choices and scheduling decisions; and to monitor and evaluate their own work progress.

In addition, four dimensions--Multi-Age Grouping, Instructional Teaming, Personnel Preparation, and Parent Involvement--provide school- and district-level support for the implementation of adaptive instruction programs. These dimensions are described below.

13. Multi-Age Grouping. Multi-age grouped, or ungraded, classrooms accommodate students whose learning progress is unusually slow, average, or fast; provide for effective use of teachers' instructional time; and encourage peer modeling and peer tutoring. In ungraded classrooms, students are described in terms of their instructional needs rather than according to chronological age, and

individual differences are viewed by teachers, peers, and parents as the norm rather than as exceptions. While teachers are the primary instructional resource for students, multi-age grouping provides a natural setting for spontaneous and planned peer modeling and peer tutoring which enhance the academic and social development of tutors and tutees alike. All students, with their individual strengths, have opportunities to serve as important social and academic resources for each other.

14. Instructional Teaming. Teaming provides more flexibility and more effective utilization of instructional resources such as teacher time and talents. It allows for a wide range of instructional styles and provides for flexibility in scheduling. Students in classrooms with instructional teaming have been found to spend more of their school time receiving instruction than students in self-contained classrooms. Other effects include the promotion of closer relationships among teachers and students and the provision of more learning alternatives which, in turn, results in greater student achievement and improvements in students' self-concepts and attitudes toward school.

15. Personnel Preparation. The primary goal of personnel preparation activities is to improve schools' capabilities to provide quality educational services for increasingly more diverse student populations. Training sessions conducted in the context of the staff's daily work are scheduled on a regular basis. Adequate personnel preparation provides the support necessary for school staff to become increasingly more self-sufficient in monitoring and diagnosing their implementation needs as well as more proficient in establishing and maintaining a high degree of implementation of adaptive instruction.

16. Parent Involvement. Activities are designed to increase communication between home and school in order to help meet the learning needs of individual students. A typical strategy is to teach parents how to teach their child or how to interact with their child in certain cognitive activities. Although parent involvement may take a variety of forms, it should minimally include awareness activities to insure that parents are knowledgeable about their child's learning plans, the school curriculum, and their child's progress within the curriculum.

Clustering of Program Dimensions and Functions They Serve

It is important to note that while the program dimensions described above are design features and classroom practices that have been found to be effective by many researchers and practitioners (e.g., Brophy, 1979; National School Public Relations Association, 1981; Walberg, 1983; Wang, 1983c), the presence of any single dimension alone is unlikely to lead to effective adaptive instruction. Rather, it is the complementary integration and implementation of clusters of the dimensions as components of a comprehensive system that is essential for achievement of the desired classroom processes and outcomes. In this section, the hypothesized interactive effects of clusters of related dimensions are discussed in terms of their major functions in program implementation.

Integrated diagnostic-prescriptive process. An integrated diagnostic-prescriptive process has come to be identified as necessary for the effective provision of adaptive education. Dimensions that directly contribute to the implementation of that process include

Diagnostic Testing, Monitoring and Diagnosing, Prescribing, and Record Keeping. Diagnostic-prescriptive processes allow for assessment of each student's entering learning behaviors (Diagnostic Testing); development of individualized learning plans (Prescribing); and continuous monitoring and assessment of every student's learning progress (Monitoring and Diagnosing, Record Keeping). These dimensions are designed as intervention strategies that ensure predominantly successful learning experiences, even for those students who initially are the least able. It is contended that this success in school learning is likely to lead to the development of students' sense of competence which, in turn, produces self-confidence and a sense of self-efficacy. It has been found that such heightened self-esteem results in increased amounts of time spent on learning and greater motivation to learn (e.g., Bandura, 1977; Bloom, 1976, 1980; Covington & Beery, 1976; Wang, 1983a).

A major design task for programs that incorporate a diagnostic-prescriptive process is the development and sequencing of psychologically and pedagogically meaningful learning hierarchies (Resnick, 1973; Wang & Resnick, 1979; Wang, Resnick, & Boozer, 1971). These learning hierarchies form the basis for a criterion-referenced diagnostic system that provides teachers with information on the presence or absence of specific competencies and, thereby, ensures each student's placement at an appropriate point in the learning sequence. In addition, learning hierarchies enable teachers to structure learning experiences so that mastery of initial curricular objectives provides the prerequisite learning skills for mastery of later objectives. Thus, it is anticipated that students will neither repeat tasks they already have mastered nor work on objectives for which they lack critical prerequisite skills. The fine-grained steps in the learning hierarchies form natural checkpoints in the curricular continuum, permitting students who either acquire certain skills before entering the program, or acquire them after a short time in the program, to move ahead to more complex tasks. (See module, entitled "Curriculum-Based Assessment and Evaluation Procedures," in this series.)

Systematic provision of a wide range of instructional-learning options. A variety of learning options is assumed necessary, not only to increase students' interest in and motivation for learning, but also to provide appropriately adaptive learning experiences. Three dimensions directly relate to the effective provision of a wide range of instructional-learning choices. These dimensions are Arranging Space and Facilities, Creating and Maintaining Instructional Materials, and Managing Aides. It is expected that when a variety of paper-and-pencil and manipulative materials (Creating and Maintaining Instructional Materials) is combined with adequate space and facilities (Arranging Space and Facilities) and effective management and use of the expertise of paraprofessionals and other adults in the classroom (Managing Aides), increased opportunities are provided for accommodating both the unique learning needs of each student and the nature and types of skills to be mastered. One anticipated outcome is frequent and consistent success in learning. Such success, in turn, is likely to sustain students' motivation to continue spending the time needed for further learning (Wang, 1980a).

Instructional-learning management system. The scheduling of learning activities and instructional time and the accessibility of resources and facilities have posed major implementation problems for adaptive instruction programs. Developing Student Self-Responsibility and Establishing and Communicating Rules and Procedures are two critical dimensions that have been shown to facilitate effective management of classroom instruction in general (Evertson & Anderson, 1978) and adaptive instruction in particular. In the past, scheduling choices were limited to group instruction versus individual instruction, free-choice versus teacher-prescribed activities, and teacher instruction versus independent student work. Effective implementation of adaptive instruction, however, requires the inclusion of all these alternatives (Wang, 1974). Design consideration must be given to providing the support required for efficient use of time, space, and material resources by teachers and students. Thus, the establishment and explicit communication of rules and procedures (Establishing and Communicating Rules and Procedures) and the explicit delegation of increased responsibility to students for planning and completing their own learning tasks (Developing Student Self-Responsibility) are dimensions considered instrumental in the establishment of guidelines for teachers' and students' use of resources. Incorporation of these dimensions into classroom management processes frees teachers from routine classroom and instructional management tasks and allows them to concentrate on teaching (Wang, 1979, 1981b).

One of the major effects of a management support system is a decrease in the information overload that teachers are bound to experience in the implementation of adaptive instruction programs. In his review of recent developments in the cognitive sciences, Simon (1981) has pointed out that aside from motivation and external opportunities and incentives, the major constraints against performance of demanding cognitive activities are the few items of information that can be held in immediate conscious memory and the time required to store an item in long-term memory. Thus, attention and memory are limiting factors that must be considered in the provision of adaptive instruction. In this complex process, teachers are required to process information about each student's learning progress on an ongoing basis. They need to evaluate and design alternative plans to facilitate mastery of learning objectives. Instructional decisions are based not only on student cues, but also on information about the availability of alternative strategies and materials. The ways in which such information is put to use are complicated further by each teacher's own beliefs about education and the particular instructional practices to be utilized, as well as his or her perceptions of individual students' needs and characteristics. Therefore, a major focus in the design of program implementation support for adaptive instruction has been the identification of ways to help teachers become efficient in information processing. Effective instructional-learning management systems ensure such support by relieving teachers of some of the information burden involved in routine classroom management and placing more responsibility in the hands of students.

Research evidence (e.g., Brown, 1978; Phares, 1968) suggests a close relationship between self-management and efficient learning. Pines and Julian (1972) found, for example, that students who were competent self-managers showed more initiative and made more use of previously learned principles in problem solving than did other students. Moreover, teaching students to become effective managers of their classroom learning and behavior has been found to enable teachers to allocate more time to teaching and related instructional matters (Smith, 1976; Stone & Vaughn, 1976) and less time to managing students

(Borg & Ascione, 1982; Evertson & Anderson, 1978; Kounin, 1970). The development of self-management skills is expected to increase students' motivation and reduce the amount of system-imposed distraction in the learning environment. Strengthening students' basic academic and self-management skills is viewed as a way of increasing their sense of self-efficacy or personal control over their learning and, thereby, increasing their willingness to spend the amount of time needed for learning. Furthermore, students' acquisition of self-management skills is seen as a way of maximizing the amount of time actually spent on learning and instruction. In turn, it is anticipated that increased teacher instructional time is likely to improve the quality of instruction and, as a result, reduce the amount of time needed for learning.

School-wide organizational support system. One of the most frequently cited causes of the unsuccessful implementation of innovative practices in schools is the lack of well-defined organizational supports (Anderson, 1973; Conner, 1976; Decker & Decker, 1977). Dimensions that are directly relevant to the development of a school-wide organizational support system are Instructional Teaming, Multi-Age Grouping, Personnel Preparation, and Parent Involvement. Adaptive instruction requires the effective utilization and management of all available resources (e.g., school time, teachers' and students' talents, parents' interest in their children's education) in ways that lead to an increased number and variety of instructional and learning alternatives.

By working together in a team for instructional purposes and sharing their talents and school resources (Instructional Teaming), teachers can increase their flexibility to allocate and use school time.

Students in classrooms where this dimension is implemented have been found to spend more of their school time receiving instruction, compared to students in self-contained classrooms (e.g., Cohen, 1976; Schmuck, Paddock, & Packard, 1977). Through instructional teaming, teachers can provide a wider variety of instructional alternatives (Adams, 1962; Arikado, 1975; Wang, 1976) and teaching styles (Dawson & Linstrom, 1974). In addition, many studies have found significant differences in students' achievement, as well as in their self-concepts and attitudes toward school (e.g., Klausmeier & Quilling, 1967; Pribble & Stephens, 1976), in classrooms where some forms of instructional teaming were implemented.

Ungraded classrooms (Multi-Age Grouping) provide the flexibility necessary for accommodating differences among students, particularly those who tend to make unusually slow or fast progress. Through the integration of students who are at different developmental and academic achievement levels, multi-age grouping results in frequent opportunities for spontaneous and planned peer modeling and peer tutoring (Allen 1976; Wang & Weisstein, 1980). Aside from the socialization functions that have been attributed to peer groups in the literature (e.g., Allen 1976; Demos & Demos, 1969; Erickson, 1963; Lippit, 1976), cross-age peer tutoring situations have been found to contribute to the school achievement and motivation of tutors and tutees alike (Fogarty & Wang, 1982b; Lohman, 1970; Peifer, 1972). Although some spontaneous peer tutoring and modeling might occur in graded classrooms, the greater age span in multi-age grouped classrooms generally tends to result in a wider range of student talents, skills, and interests. When viewed as instructional resources, these student characteristics are a source of additional time for instruction and learning. The common occurrence of peer tutoring in multi-age grouped classrooms also enables teachers to spend greater amounts of instructional time with those students who require more teacher assistance. (See module on peer and cross-age tutoring by Joseph and Linda Jenkins in this series.)

The establishment and maintenance of innovative educational programs require the ongoing support of systematic training activities (Personnel Preparation) which promote understanding of the programs and which are directly related to day-to-day implementation. Findings from a number of research and development efforts have pointed to the important supportive role played by pre-service and in-service personnel preparation that adapts to the needs and talents of individual staff (e.g., Cruickshank, Lorish, & Thompson, 1979; Griffin, 1979; McLaughlin & Marsh, 1979; McNergney, 1980; Miller & Wolf, 1979; Perry, 1980; Zigarmi, Amory, & Zigarmi, 1979). It is expected that the increased proficiency gained from such training can result in reductions in the amount of time needed for instruction and learning as well as subsequent increases in time available for, and spent on, learning. Because of the unique program design requirements of adaptive instruction and the fundamental changes in student and teacher roles required to effectively establish and maintain a high degree of implementation, development of a comprehensive system of personnel preparation that provides school personnel with appropriate technical assistance must be a major focus.

Given the limited amount of time in the school day, students in even the most systematically designed and effectively implemented educational programs can benefit from additional instructional reinforcement at home (Parent Involvement). The Parent Involvement dimension provides students with additional instructional resources through increased communication between school and home and the active participation of parents and other family members in their children's learning. Research evidence shows that intervention programs designed to involve parents in significant ways are more effective than programs aimed exclusively at students (e.g., Bronfenbrenner, 1974; Karnes & Zehrbach, 1977; Lally & Honig, 1977; Levenstein, 1977; Powell, 1979; Schaefer, 1972; Weikart, Epstein, Schweinhart, & Bond, 1978). In addition to the increased learning time that is facilitated by parent involvement activities, it is expected that students' motivation to spend time on their learning will be increased as a result of greater parental interest in what they do in school and in their schooling success. (See module on parent-teacher interactions by Roger Kroth and Roberta Krehbiel in this series).

A Final Note on the Model

It is important to point out that the design characteristics identified in the conceptual model of adaptive instruction described above represent ideals to strive for in developing adaptive school learning environments. Local constraints and other restricting factors should be considered as the model is put into operation. In every case, it is necessary to adjust priorities and flexibly adapt the program to local situations and needs. Multi-Age Grouping, for example, is listed as a critical organizational support. Realistically, however, it may not be feasible in all settings and it is certainly possible to implement adaptive instruction without multi-age grouped classrooms. Thus, Multi-Age Grouping may enhance implementation of adaptive instruction, but it is not absolutely essential. Diagnostic Testing, on the other hand, is one program dimension which is indispensable in effective implementation of adaptive instruction.

Evaluating Adaptive Instruction

Measurement and Procedures

A major conceptual and methodological concern in the evaluation of adaptive instruction is the sensitivity and adequacy of measures. Studies of adaptive instruction programs in the past typically have produced results that are both inconclusive and controversial. It has been noted that a major weakness of most efficacy studies of innovative educational practices in general, and adaptive instruction programs in particular, has been the inadequacy of the measures and procedures. The general lack of content validity in dependent measures has been of particular concern (Fullan, 1981; Lindvall & Nitko, 1981; Wang & Ellett, 1982). More specifically, underrepresented samplings of unique program goals has been seen as one of the most serious weaknesses (e.g., Raven, 1981).

Another point of controversy has been the instructional sensitivity, or the validity, of using standardized achievement tests as a study's primary dependent measure (e.g., Burstein, 1981; House, 1981; Marshall, 1981; Raven, 1981). Studies of innovative educational programs frequently have been based on the assumptions that the sole goal of all instruction is academic achievement, and that academic achievement is best assessed by standardized achievement tests. Thus, assessments of diverse program goals have tended to be overshadowed by dependence on achievement scores as the only measure of program efficacy. A cursory review of the stated goals of selected adaptive instruction programs illustrates a wide variety of program goals that past evaluations have treated inadequately, if at all, as dependent measures. For example, the Winnetka Plan--the classic example of adaptive instruction--includes socialization, self-expression, and cooperation as desired outcomes (Washburne, 1925). A later program, the Program for Learning in Accordance with Needs (PLAN), is designed to achieve far-reaching, non-academic goals such as preparation of students for appropriate occupational roles, for the responsibilities of citizenship, and for satisfying use of leisure time (Flanagan, 1967). Other examples of diverse program goals can be found in the descriptions of selected model programs of adaptive instruction discussed earlier in this module.

In addition to the failure to examine a broad range of program outcomes, past evaluations have often failed to include information on the specific nature of program implementation. The result has been a lack of evidence for relating program implementation to outcomes (Fullan & Pomfret, 1977; Wang & Ellett, 1982; Wholey, 1979). Information on the extent to which critical features of a given program are implemented in accordance with the program's design, as well as information on the extent to which adaptations are made by users, is critical in linking program implementation and efficacy. The availability of such a data base is particularly important for studying the effects of innovative educational practices, such as adaptive instruction, that require major changes in classroom procedures and teacher and student roles. At issue here is the validity of making causal links among a program's design, its implementation, and its outcomes on the basis of available data. These kinds of analyses require a research design and procedures that permit the attribution of program effects to the presence of specific design dimensions.

The notion of including measures of program implementation in the assessment of a program's efficacy is not new. Several widely recognized evaluation research models include program implementation and processes as major elements (e.g., Alkin, 1969; Cooley, 1971; Stake, 1967; Stufflebeam, 1968). Nevertheless, implementation information rarely is included in studies of innovative programs as supporting evidence for linking program design to findings of effectiveness or non-effectiveness. In the study of adaptive instruction programs, for example, information on the frequency of diagnostic testing and the use of diagnostic test results for instructional planning is considered an objective indicator of the extent to which adaptive instruction takes place. Therefore, in order to interpret validly the efficacy of using diagnostic-prescriptive procedures to improve student learning, measures of how tests are administered and how the subsequent information is used are essential. Another example of important implementation related information for many adaptive instruction programs is the degree to which open-space design is adopted (an independent variable and indicator of the degree of program implementation) and the subsequent frequency of spontaneous social and peer-tutoring interactions. A related level of analysis of program implementation and outcomes involves examining the relationship between increased spontaneous peer interactions (an hypothesized mediating variable resulting from the implementation of open-space design) and students' perceptions of their cognitive and social competence and their attitudes about school (dependent variables).

Thus, information on what is implemented--the independent variable in studies of educational innovations--is essential for linking program effects and key program features. This kind of firsthand information on day-to-day operation and general program impact can provide answers to questions such as, "Do we have the personnel and other resources to operate this program?"; "Is the program one which we would like to see functioning in our schools on a daily basis?"; "What are the contexts and conditions under which program implementation occurs?"; and "What is the specific linkage between implementation of each aspect of the program and its intended outcomes?" An illustration of one method of providing a data base to answer these implementation related questions is provided in the following section.

Assessing Degree of Program Implementation: An Illustration

A description of the design of an instrument for evaluating program implementation is presented in this section for illustrative purposes. This description is included to provide a concrete example of how critical program dimensions or features can be operationalized and incorporated into a measurement instrument for determining the degree of program implementation.

As previously discussed, the overall objective of evaluating program implementation is to obtain information on the presence or absence of critical program features. This kind of information furnishes the conditions or contextual framework for meaningful interpretations of program outcomes. While the need to include assessments of program implementation in all program evaluation efforts has been recognized, the lack of methodology and measures seems to be a persistent cause of the dearth of implementation related data in past evaluations. The root of the problem, it is contended, is inadequate conceptualization of most programs and of specific program dimensions that are critical to effective implementation. This contention created the impetus for the development and validation of the instrument for documenting program implementation discussed below. Although this instrument was designed for use in the implementation of a particular program, it may be easily adapted for use with other programs of adaptive instruction due to the generic nature of the majority of the program's design features.

The instrument, the Implementation Assessment Battery for Adaptive Instruction (Wang, 1980b) is designed to provide information on the nature and patterns of the implementation of the Adaptive Learning Environments Model (ALEM). Data obtained from the Battery are used in the evaluation of the degree of program implementation and, subsequently, in the design of pre-service and in-service training and other activities aimed at improving implementation. To provide some background information on the type of program the Battery is designed to assess, the ALEM is described briefly below.

The Adaptive Learning Environments Model. The ALEM aims to provide school learning experiences that effectively accommodate the needs of individual students in regular classroom settings (Wang, 1980a). The expected outcomes of the ALEM for each student include opportunities to successfully acquire skills in academic subject areas through an individually tailored and optimally paced progress plan, development of competence in taking responsibility for self-management of learning and behavior, and a sense of social and cognitive competence and self-esteem. At the same time, as teachers become proficient in implementing the program, they are expected to be able to spend more time providing instruction than managing students. An underlying premise of the ALEM's design is that the teaching of basic skills need not be sacrificed in order to foster students' involvement in making curricular choices and in planning and evaluating their own learning. Both sets of objectives can be achieved through systematic programming and close monitoring of program implementation.

Basically, the ALEM is a product of the integration of aspects of prescriptive instruction that have been shown to be effective in producing basic skills mastery (Bloom, 1976; Glaser, 1977; Rosenshine, 1979) with aspects of informal education that generate attitudes and processes of inquiry, independence, and social cooperation (Johnson, Maruyama, Johnson, Nelson, & Skon, 1981; Marshall, 1981; Peterson, 1979). Among the distinctive design features of the program are a comprehensive system that adapts instruction to the needs of individual students; a built-in support system that is based on the involvement of school administrative and instructional support personnel, health professionals, and families; and use of a "full-time" rather than a "shared-time" approach to providing for the special education needs of regular and exceptional students. Detailed descriptions of supporting research that has been carried out in the development and evaluation of the ALEM can be found in a number of documents (e.g., Wang, 1981a, 1983b, 1983d; Wang & Birch, 1983; Wang & Walberg, 1983a).

Design of the Implementation Assessment Battery for Adaptive Instruction. Development of the Battery began with identification of the critical dimensions of the ALEM, based on a systematic analysis of the program's structural and action domains. The structural domain consists of program dimensions related to resources such as space, facilities, instructional materials, and classroom rules and procedures. The three critical dimensions in the structural domain are Arranging Space and Facilities, Creating and Maintaining Instructional Materials, and Establishing and Communicating Rules and Procedures. The action domain, on the other hand, consists of program dimensions related to those roles and behaviors of instructional staff and students that are required for effective utilization of instructional and learning resources. The nine critical dimensions in the action domain are Managing Aides, Record Keeping, Diagnostic Testing, Prescribing, Monitoring and Diagnosing, Interactive Teaching, Instructing, Motivating, and Developing Student Self-Responsibility. While a number of the critical dimensions are indigenous to the ALEM (e.g., Developing Student Self-Responsibility), others are classroom practices associated with a variety of educational approaches.

Each of the critical dimensions is characterized by a group of specific performance indicators. The extent to which the performance indicators for a given dimension are present provides an index of the degree of implementation of that dimension. A total of 106 performance indicators have been identified (see the Appendix). They constitute the specific items included in the Implementation Assessment Battery for Adaptive Instruction. Due to differences in the nature of the various performance indicators, assessment of their presence or absence requires different techniques and procedures. Two types of procedures are used in administering the Battery: classroom observations and interviews with teachers and students.

Depending upon the specific information required, the assessment items, or performance indicators, are grouped into one of six data collection forms: the Observation Checklist for Physical Design of the Classroom, the Observation Checklist for Classroom Records, the Teacher Instructional Roles and Interactions Observation Form, the Student Learning Process and Behaviors Observation Form, the Student Interview Schedule, and the Teacher Interview Schedule. The Observation Checklists (Physical Design of the Classroom, Classroom Records) focus on non-dynamic observables; that is, they assess the presence or absence of those resources that must be in place to ensure a high degree of program implementation (e.g., appropriate physical layout of the classroom, operational student self-management system, integration of learning tasks with curricula, complete and up-to-date classroom records). The Observation Forms (Teacher Instructional Roles and Interactions, Student Learning Process and Behaviors) focus on dynamic observables. They are designed for use in observing the specific processes and behaviors that occur as teachers and students function in ALEM classrooms (e.g., prescription of learning tasks, interactive teaching, independent location and appropriate use of materials and equipment by students, use of self-scheduling procedures by students). In contrast with the observation procedures, the Interview Schedules (Student, Teacher) are designed to assess the presence or absence of performance indicators which are not readily observable. These include students' and teachers' perceptions of the various conditions and procedures operating in the classroom.

Design of Personnel Preparation Programs: Relevant Contextual and Substantive Developments

Developing alternative ways to prepare educational professionals, to improve their capabilities, and to continuously enhance their skills has always been a major focus of the work of those responsible for designing and implementing pre-service and in-service training for school personnel. However, two recent developments have resulted in the current intense push for the restructuring of pre-service training programs and the provision of professional development opportunities. These developments are current school improvement needs and the technological advances and expanding knowledge base on the theories of learning and instruction and improved educational practices. As a result of these contextual and substantive developments, significant changes are occurring in the expectations and role definitions of educational professionals and in the availability and scope of personnel preparation and continuing professional development programs.

Professional Development and Current School Improvement Needs

As already noted, public sentiment, economic realities, and recent Federal and state legislation have created mandates for school change. Schools, in response to these challenges, have been faced with the charge of identifying and implementing innovative programs aimed at better serving the diverse learning needs of children and young adults of all races, language groups, social classes, and educational characteristics. However, educational improvement requires more than just the availability of workable and effective programs. Too often, those responsible for operationalizing innovations encounter great difficulty in the adoption and implementation of valuable ideas, programs, and products because of inadequate training. Moreover, the increased pressure for innovative school improvement efforts has been accompanied by declining enrollments and dwindling Federal subsidies. The result typically has been cutbacks in the hiring of additional staff. Thus, greater public demand for improved educational services, combined with reduced staffing resources, has only served to intensify the pressure on school personnel who are often criticized quite vocally for the quality of education they provide.

School personnel look to those responsible for personnel preparation in colleges of education to develop alternative ways to improve the skills and capabilities of in-service and pre-service personnel. The "least restrictive environment" mandate of Public Law 94-142, for example, challenges schools to implement innovative practices such as mainstreaming (Blietz & Courtnage, 1980; Glick & Shubert, 1981; Joyce & Showers, 1980; Sabatino, 1981). Accomplishment of this objective, however, requires the provision of ongoing professional training to support the establishment and maintenance of such innovations. Colleges of education, therefore, are pressured to redirect their training of educational personnel to methods of providing instruction that is adaptive to the special needs of individual students in regular classrooms.

Substantive Developments Related to the Provision of Adaptive Instruction

Recent developments in cognitive psychology and the research on effective teaching have provided a substantive base for improving the knowledge and skills of school personnel for implementing adaptive instruction programs. Some of these developments are in the areas of cognition and educational productivity and instructional decision making and interactive teaching.

Cognition and educational productivity. Following several decades of perhaps excessive preoccupation with behaviorism, psychologists' interest in cognition was renewed during the 1950's and 1960's. This renewed interest has resulted in research relevant to the understanding of human learning and schooling management. One example is the research on cognition and educational productivity. Reference to Simon's (1981) analysis of major findings on the constraints that operate against efficient information processing is made in the previous discussion of the clustering of design dimensions in adaptive instruction programs.

Findings on the limiting factors in most human activities, such as bounded rationality and the scarcity of attention and time, have great implications for furthering understanding of teachers' mastery of a complex system of adaptive instruction and the ways to promote teaching expertise and productivity (Wang & Walberg, 1983b). These findings have come into play, for example, in the planning and implementation of instruction as well as in the identification of those substantive and psychological factors that influence effective processing of the wide array of information involved in adapting instruction to differences among individual students. Adaptive instruction requires ongoing processing of information on each student's learning history and current performance (student cues) as teachers evaluate, and make alternative plans to facilitate, the student's mastery of learning objectives. Teachers must make instructional decisions based not only on student cues, but also on information about the availability of alternative strategies and materials as well as the nature of the tasks to be learned. Furthermore, the ways in which such information is put to use in the provision of adaptive instruction also are influenced by each teacher's personal beliefs about education and about the potential effectiveness of particular strategies with specific students. Thus, it is clear that teachers face immense cognitive complexity in implementing adaptive instruction in classroom settings (Borko, Cone, Russo, & Shavelson, 1979; Clark & Yinger, 1979; Fogarty & Wang, 1982a). Consequently, one major research agenda is to further understanding of, and develop ways to compensate for, limiting cognitive factors.

Instructional decision making and interactive teaching. Effective provision of adaptive instruction requires two types of instructional decisions: instructional planning decisions made outside the classroom, and on-the-spot decisions related to the identification of alternatives and adaptations during instruction. In the conventional approach to instruction, decision making tends to be restricted either to planning sessions that are held prior to actual classroom instruction or to periods reserved for curriculum and program development. These pre-formulated determinations are called planning decisions. Increasingly, however, research on effective teaching points to the need to refine and adjust planning decisions during the actual instructional-learning process to effectively adapt to students' changing needs. This ongoing process has been termed interactive instructional decision making (Clark & Yinger, 1979; Fogarty & Wang, 1983; Semmel, 1977; Shavelson, 1976).

Planning decisions and interactive instructional decisions have different characteristics. Planning outside the classroom often involves deciding which subject matter to teach, which order and content of learning activities to implement, and which classroom management system to use. Interactive instructional decisions, however, tend to involve issues such as how to best direct student attention to a task, how much and what type of feedback to present, how to determine the misconceptions that have led to student errors, and how to repair student misconceptions. Thus, interactive instructional decisions are often concerned with fine-grained issues, and they are often based on the immediate performance cues that teachers receive during the instructional-learning process.

Jackson (1968) found that teachers in ordinary classrooms engage in 200 to 300 interpersonal exchanges an hour and that their language reveals "an uncomplicated view of causality; an intuitive, rather than rational approach to classroom events; an opinionated, as opposed to an open-minded stance when confronted with alternative teaching practices; and a narrowness in working definitions assigned to abstract terms" (p.144). Rosenshine (1982) argues that expert teachers can go far beyond these kinds of simple expressions, but that such expertise may be rare and may take years, if not decades, to acquire. As a consequence, students in conventional classroom settings often receive inconsistent or vague information about learning goals and uninformative mass-processed feedback about their performance (Doyle, 1977). They also are made to wait. Jackson (1968) found that delay, denial, interruption, and distraction typify classroom life; patience seems to be the greatest virtue.

To make instructional decisions which are relevant to student needs, teachers need to be proficient in the ongoing processing of information on each student's learning progress, as well as in making alternative plans to facilitate each student's mastery of learning objectives. Thus, a major task for teacher development involves finding ways to develop the kind of efficacy in information processing that is required for on-the-spot decision making during the ongoing instructional-learning process.

Characteristics of Effective Teacher Education Programs

The contextual and substantive developments discussed above point to several characteristics that should be included in the design of effective training of in-service teachers and teachers-in-training in general, and in training aimed at fostering the effective practice of adaptive instruction in particular. These characteristics include (a) a curriculum focus that accentuates professional collaboration and integration of the work of the many educational professionals who are directly or indirectly involved in the provision of educational services; (b) a programming approach that systematically incorporates school-based demonstrations of innovative practices; and (c) built-in procedures that enable trainees to continue to improve their implementation, refine their work, and identify their own further training needs.

Professional Collaboration

Research evidence and firsthand experience clearly suggest that if the special needs of individual students are to be met adequately and with consistency, each student's total school learning experience must be designed jointly by special and regular education teachers. Awareness of this basic challenge causes many observers to feel that Public Law 94-142 may be the straw that is breaking the camel's back--either for "good," if it brings about a fundamental reconstruction of school programs to improve education for all students as well as to accommodate the needs of mainstreamed handicapped students; or for "ill," if educators settle for nonadaptive mainstreaming education that has no effect on the status quo. It is clear that serious efforts to improve educational services through adaptive instruction will require important transformations in regular classes as well as in special programs and the ways in which the programs operate and interact in schools. These transformations, in turn, will result in the reassessment and redeployment of present personnel resources in both special and regular education--a fact which has important ramifications for teacher education programs.

Operationalization of adaptive instruction and the resultant redeployment of organizational and other resource supports require fundamental changes in the roles and functions of school personnel. A first step in this direction might be to utilize a systems approach in the establishment of functional linkages and integrated services among regular, remedial, and special education professionals who currently work, for the most part, in separate and independent fashions (Blackhurst, 1982; Reynolds & Wang, 1981). Multiple perspectives, ranging from the utilization of school resources, to organizational and staffing patterns, to the qualifications and motivation of staff for implementing change, to the availability of staff development resources at the school and district levels, need to be considered. All are critical topics for personnel preparation and continuing professional development. As such, they also represent fundamental considerations in any effort to sustain changes aimed at improving schools' capabilities to provide quality educational services.

The preparation of teachers for effective implementation of such a collaborative model of service delivery also requires professional collaboration at a different level. This collaboration involves several professional groups who have been involved in teacher training in the past but generally have tended to work in disparate contexts. These groups are (a) central and building administrators and policy makers in the local school districts who are responsible for providing the administrative and resource supports to institutionalize a continuing professional development program, (b) teachers and other specialized professional personnel in local schools who could participate in the development and effective demonstration of innovative practices and improved programs, (c) faculty of colleges of education who generally are responsible for providing in-service and pre-service training for local school personnel, and (d) developers of innovative practices and programs who can provide the technical and training expertise for personnel from collaborating districts and teacher training institutions. Widespread implementation of innovative practices, particularly educational restructuring of the magnitude required by legislation such as Public Law 94-142, cannot be attained fully without the active involvement of all four groups (Wang & Glaser, 1980).

The notion of involving schools, college staff, and the developers of innovative programs in demonstration and training is not new. In fact, it has been a widely accepted practice in a number of large-scale school improvement efforts such as the Head Start planned variation program (Rivlin & Timpane, 1975) and the National Follow Through Program (Hodges, Branden, Feldman, Follins, Love, Sheehan, Lumbley, Osborn, Rentfrow, Houston, & Lee, 1980). However, the involvement of teacher training institutions as resources or partners in personnel preparation for the implementation and dissemination of innovative practices through school-based, demonstration-training is relatively rare. Nevertheless, some recent developments signal a positive move in this direction. Examples are the establishment of teacher centers and the Deans' Grants Programs sponsored by the National Support Systems Project of the University of Minnesota (Reynolds, 1982). Such models are viewed as an appropriate first step in the involvement of teachers and teacher training institutions in the development and dissemination of innovative concepts and practices. In the case of the Deans' Grants Programs, however, the involvement of local schools has been a major missing component (Teaching Research, 1981). Thus, it seems that the logical next step in extending the Deans' Grants approach is to create a collaborative model that involves school-based demonstration of innovations and teacher education programs. The type of collaborative venture suggested here takes into account the needs and interests of practitioners, as well as the utility of school-based demonstration, in the establishment of a continuum of teacher preparation. Perhaps most important, this approach would help forge the programmatic link between pre-service courses, the induction of novices, and in-service training.

School-Based Demonstration and Training

Demonstration is unquestionably a useful awareness device for illustrating concepts and educational improvements, such as adaptive instruction, about which parents, teachers, administrators, and policy makers often only read (Bandura, 1969; Becher & Ade, 1982; Joyce & Weil, 1980). However, demonstration cannot effectively bring about change unless innovations are seen as part of a comprehensive program in school and personnel preparation settings. Moreover, limited merit is attached to innovative practices unless they are viewed by potential users as having practical implications for daily operations and as being integrally related to current program implementation plans. Furthermore, school-based demonstration and training highlight the importance of coordinating the efforts of all those who perform roles in the provision of effective schooling. In school-based demonstration, the emphasis is shifted from relaying information about the theory and knowledge underlying an innovation to placing the innovation in the context of actual school settings. Major functions of demonstration schools are the modeling of new educational possibilities and the display of salient features of successful programs--their utility, efficacy, and implementability. One expected outcome of involving the total school as a demonstration unit is the linkage of positive changes in actual school situations to the implementation of specific practices (Wang & Glaser, 1980).

School-based demonstrations also serve as important clinical settings for personnel preparation. They are particularly useful in highlighting the interrelation and interdependence of the roles and functions of various school personnel whose work is tied closely to the education of students with special needs. By contrast, the approach of conventional university-based teacher education programs, whereby separate training programs address specialized functions (e.g., learning disabilities teachers, remedial reading teachers) has not addressed the interrelatedness of tasks in any detailed or profound way. Rather, the focus has been on instilling only a general awareness of the work of others.

The significant advantages associated with the incorporation of school-based demonstration in a training program include the following:

1. Concrete illustrations are provided of the possibilities for merging ideals with the realities of schools and communities and replicating innovations in actual school settings.

2. The value of innovations for meeting particular current needs, as well as their impact on total school improvement efforts, is highlighted. Furthermore, demonstration illustrates that successful implementation of innovative practices requires a comprehensive plan for training all those involved in the establishment and maintenance of the practices.

3. Teachers and all related school personnel are credited with accountability for effective program implementation.

4. Visibility is attached to the critical features of innovations, along with the consequences for students, teachers, parents, administrators, and supporting personnel.

5. Training is both information-based and process-based, resulting in an understanding of concepts and the development of needed skills.

6. Training is provided for both teachers and those administrators who are responsible for implementing and maintaining innovations.

7. As a catalyst for the development and implementation of innovations, demonstration produces a ripple effect whereby the dissemination and diffusion of innovative practices and programs are facilitated.

Individually Tailored Approach to Training and Program Maintenance

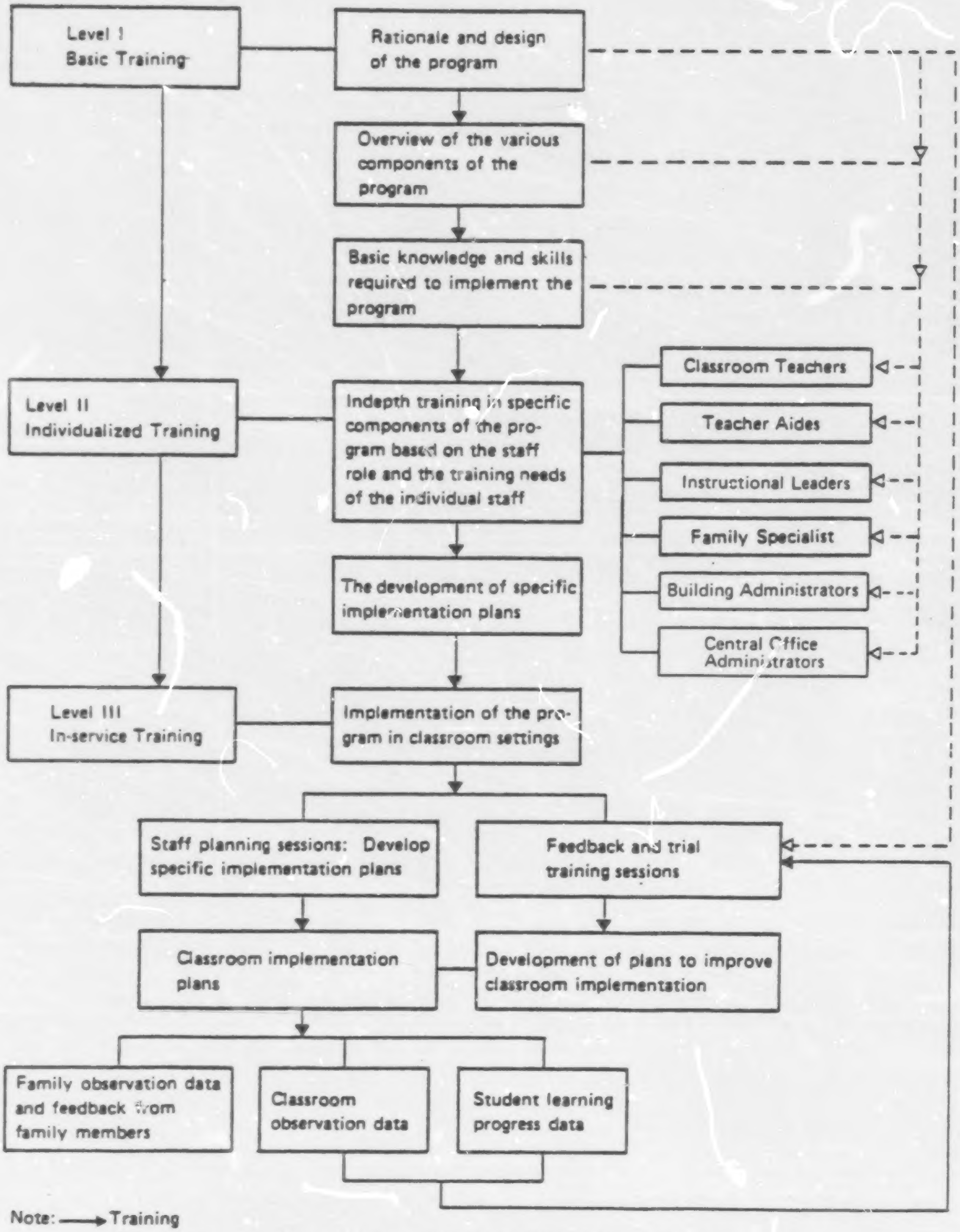
The establishment and maintenance of innovative school programs require not only detailed specification and understanding of the programs' designs and operating features, but also training in the competencies required for day-to-day implementation (Wang, 1981c). To this end, personnel preparation programs must include a systematic mechanism that provides, on a continuing basis, information on the nature and pattern of program implementation and/or the identification of further training needs of individuals responsible for implementing the program.

Like all learners, teachers and other professional and paraprofessional staff learn in different ways. More importantly, they come to their jobs at different stages of development. Thus, it is essential that training be tailored to the identified strengths and weaknesses of individuals, rather than to those of the group at large. In addition to providing training that is adaptive, teacher education programs must include a built-in system for monitoring implementation to insure program maintenance. Teachers need frequent contact and continuous support in their efforts to solve both short-term and long-range problems (e.g., Cruickshank, Lorish, & Thompson, 1979; Griffin, 1979; McLaughlin & March, 1979; McNergney, 1980; Miller & Wolf, 1979; Perry, 1980; Zigarmi, Amory, & Zigarmi, 1979).

The Data-Based Staff Development Program was designed to be used as a support system for the implementation and day-to-day monitoring of innovative instructional programs (Wang, 1981c; Wang & Gennari, 1983). It consists of three major components: a training sequence of three levels, a set of measures for assessing the degree of program implementation, and staff development plans that are systematically designed to meet the needs of individual teachers.

Training sequence. Figure 2 shows the levels and sequential steps of the Data-Based Staff Development Program. As outlined in the Figure, Level I is designed to provide basic working knowledge of the curriculum and procedures incorporated in a given program. In Level II, more intensive training is provided in specific staff functions. Level III provides ongoing in-service training that is designed to help individual school staff continually improve and upgrade program implementation.

1. Level I: Basic training. Training at Level I is aimed at providing an overview of the program to be implemented as well as working knowledge about the implementation requirements of the various program components. The basic training level focuses on (a) the rationale and design of the program and relevant program evaluation


Level I
Basic Training
Rationale and design of the program
Overview of the various components of the program
Basic knowledge and skills required to implement the program
Level II
Individualized Training
Indepth training in specific components of the program based on the staff role and the training needs of the individual staff
Classroom Teachers
Teacher Aides
Instructional Leaders
Family Specialist
Building Administrators
Central Office Administrators
The development of specific implementation plans
Level III
In-service Training
Implementation of the program in classroom settings
Staff planning sessions: Develop specific implementation plans
Feedback and trial training sessions
Classroom implementation plans
Development of plans to improve classroom implementation
Family observation data and feedback from family members
Classroom observation data
Student learning progress data

Note: ——▸ Training
- - -▷ Re-training

Figure 2. The Data-Based Staff Development Program.

This figure is taken from Wang, M.C., and Gennari, P. Analysis of the design, implementation, and effects of a Data-Based Staff Development Program. Journal of Teacher Education and Special Education, 1983, in press.

results; (b) the general content and objectives of the various program components; and (c) the knowledge and skills required for program implementation (e.g., information on the content covered in the curriculum hierarchy; the procedures for diagnostic testing, prescription writing, and record keeping; the design of the classroom environment; the management and display of learning materials). Level I staff development activities usually occur before program implementation is initiated in the classroom. They are designed for all relevant administrative personnel (from central administrative staff to those at the building level), as well as for instructional and other support personnel whose duties affect the provision of educational services to students. Staff development work at the basic training level generally requires two or three days.

2. Level II: Individualized training. Staff development activities at the individualized training level are designed to provide in-depth training in each staff member's functions, based on an analysis of the functions to be carried out in the implementation of the program and the assignment of those functions to various school personnel. As indicated in Figure 2, individualized training is aimed at six basic types of school personnel: classroom teachers, teacher aides, instructional leaders, family specialists, building administrators, and central office administrators. While the amount of time required for Level II training varies from school to school (depending on an individual school's unique constraints and the staff's understanding of their roles and functions), training sessions generally cover two or three days. They usually occur immediately after the basic training sessions and before program implementation begins. Experience has shown that the total staff development work at Levels I and II can be completed in a week-long workshop prior to the opening of school.

3. Level III: In-Service training. Level III training is the culmination of an interactive process of program assessment, feedback, planning, and ongoing staff development. Essentially, it provides the technical support required to establish and maintain a high degree of program implementation. Because in-service training is designed to be adaptive to the needs and expertise of individual staff, the type and frequency of Level III staff development activities vary for different schools and staff.

As shown in Figure 2, there are two types of Level III training sessions: staff planning sessions and sessions for feedback and training. Staff planning sessions are designed to develop plans for accomplishing selected instructional-learning objectives and to determine topics for staff feedback and training. Staff planning is based on information from classroom observations, measures of degree of program implementation, data on students' learning progress, and feedback from family members. Sessions for staff feedback and training are scheduled on a regular basis throughout the school year, according to staff members' needs and interests. They provide opportunities to discuss critical issues related to program implementation, particularly issues surrounding refinement and improvement in the degree of program implementation. Feedback and training sessions usually take place during regular staff planning times and/or during scheduled team meetings and in-service training times.

Use of degree of program implementation data to identify training needs. A critical design feature of Level III training is the use of degree of program implementation measures to (a) obtain information on the extent to which critical program features are implemented and the nature of implementation, and (b) use that information to identify further training needs of those implementing the program. The following section illustrates how degree of implementation data can be incorporated in the development of individually tailored training programs. The illustration is based on the experience of using the Data-Based Staff Development Program to support teacher training for the Adaptive Learning Environments Model (ALEM)--a specific adaptive instruction program described in a previous section of this module.

Degree of implementation data are obtained by administering the Implementation Assessment Battery for Adaptive Instruction. The resultant summary data are displayed in a computer printout as exemplified by Figure 3. As shown in the figure, the data are analyzed at four different levels: site (school district); school; grade level; and class (teacher). The mean scores for the critical dimensions of the program are reported in 12 separate columns. The names and acronyms for the dimensions are listed at the top of the printout. The number in parentheses under each acronym indicates the number of performance indicators included in the Battery to assess the degree of implementation of that dimension. For example, for Creating and Maintaining Instructional Materials (CMIM), shown in the second column of Figure 3, 12 performance indicators assess the degree to which the CMIM dimension is implemented as prescribed by the program's design. The printout also includes information on each teacher's degree of implementation of the 12 critical dimensions, as well as mean

Critical Dimension Codes

AS&F	Arranging Space & Facilities	PRES	Prescribing
CMIM	Creating and Maintaining Instructional Materials	M&D	Monitoring & Diagnosing
ECRP	Establishing and Communicating Rules & Procedures	IT	Interactive Teaching
MA	Managing Aides	INST	Instructing
RK	Record Keeping	MOTI	Motivating
TEST	Diagnostic Testing	DSSR	Developing Student Self-Responsibility

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School/Grade		AS&F (15)*	CMIM (12)	ECRP (15)	MA (3)	RK (3)	TEST (4)	PRES (7)	M&D (10)	IT (6)	INST (13)	MOTI (5)	DSSR (13)
School A													
Grade 1	Teacher A	87	67	73	67	33	50	71	70	67	77	60	77
Grade 2	Teacher B	93	83	87	67	100	25	57	90	50	69	60	69
Grade 3	Teacher C	87	67	80	67	67	75	86	70	83	92	80	62
Kindergarten	Teacher D	73	58	93	100	67	75	86	80	83	85	80	92
Average for School		85	69	83	75	67	56	75	77	71	81	70	75
School B													
Grade 1	Teacher E	67	75	73	67	67	75	71	80	50	77	40	54
Grade 2	Teacher F	80	67	73	33	67	25	14	60	50	62	20	46
Grade 3	Teacher G	87	83	87	67	100	75	86	90	67	85	80	85
Kindergarten	Teacher H	93	83	93	67	67	50	71	70	83	92	60	77
Average for School		82	77	82	59	75	56	61	75	63	79	50	66
Average for Site													
Grade 1		77	71	73	67	50	63	71	75	59	77	50	65
Grade 2		87	75	80	50	83	25	36	75	50	66	40	58
Grade 3		87	75	83	67	83	75	86	80	75	88	80	74
Kindergarten		83	71	93	83	67	63	79	75	83	88	70	85
Overall Average		83	73	82	67	71	56	68	76	67	80	60	71

*Numbers in parentheses indicate numbers of items (Performance Indicators) included in the Implementation Assessment Battery.

Figure 3. A sample computer printout of a summary of degree of implementation data.

This figure is taken from Wang, M.C., Catalano, R., and Butcher, M.S. Training Manual for the Implementation Assessment Battery for Adaptive Instruction. Pittsburgh, PA.: University of Pittsburgh, Learning Research and Development Center, 1983.

percentages of the degree of implementation for each grade within a particular school, for a given school, for specific grade levels across a school district, and for an entire district.

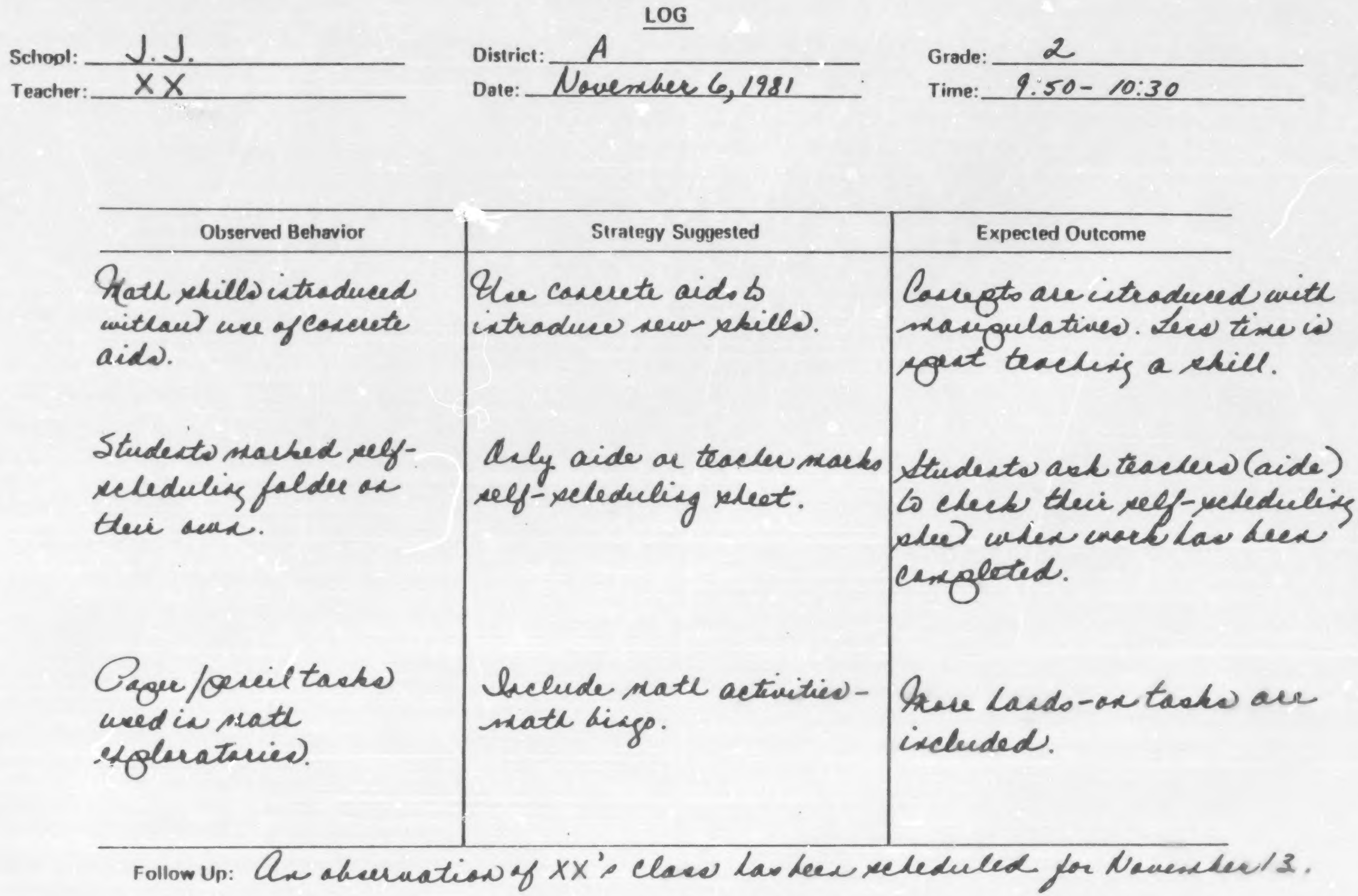
The criterion for a high degree of implementation of a critical dimension has been set at 85%. That is, when 85% or more of the performance indicators in a given dimension are observed to be present, the degree of implementation of that program dimension is considered to be "high." When 50% to 84% of the items for a given dimension are present, implementation is considered to be "average." If less than 50% of the performance indicators in a given dimension are present, implementation is considered to be "low." Using these criteria, Figure 3 shows, for example, that in School A, Kindergarten and Grade 3 achieved a high degree of implementation of the Instructing (INST) dimension. Grades 1 and 2 had average degree of implementation scores (77% and 69%, respectively, of the performance indicators present).

The overall degree of implementation across a variety of schools for an extended period of time provides evidence of the implementability of the program and its critical dimensions. In addition, the degrees of implementation of particular dimensions are analyzed for individual teachers, and the resulting information is used to estimate their training needs and develop specific staff development plans. Similarly, grade, school, and site averages are used to identify staff development needs at those levels. Analyses of the changes in degree of implementation from one assessment period to the next provide information to individual teachers about their implementation progress, as well as the data base for evaluating the effectiveness of schools' implementation and staff development efforts.

Design and implementation of adaptive staff development plans: An illustration. A basic assumption underlying the design of staff development supports that adequately meet the training needs of individual staff is that detailed information on degree of program implementation is required. This section provides an illustration of how such information can be incorporated in the development of staff development plans that are adaptive to training needs at the district, school, grade, and/or individual teacher levels.

The Data-Based Staff Development Program is operationalized in schools through comprehensive staff development plans designed at the beginning of every school year. Each school's plan is based on a variety of information, including degree of implementation data and student learning progress data from spring of the previous school year (for new teachers and/or new implementation sites, from the beginning of the school year); each school's identified staff development needs; and the major categories of activities proposed to meet those needs during the year.

Specifically, staff development plans include (a) a description of training tasks/objectives for performance indicators in critical dimensions that consistently show scores below the 85% criterion level for a significant number of teachers (and/or for a particular teacher); (b) the dates by which training is to be completed; (c) the person(s) responsible for training; (d) the type of activity to be conducted; (e) the expected outcomes; and (f) the expected evidence of effective service as it relates to successful completion of training. An excerpt from the staff development plan for School District B is shown in Figure 4.



LOG

School: J. J.
District: A
Grade: 2
Teacher: XX
Date: November 6, 1981
Time: 9:50- 10:30

Observed Behavior	Strategy Suggested	Expected Outcome
Math skills introduced without use of concrete aids.	Use concrete aids to introduce new skills.	Concepts are introduced with manipulatives. Less time is spent teaching a skill.
Students marked self-scheduling folder on their own.	Only aide or teacher marks self-scheduling sheet.	Students ask teachers (aide) to check their self-scheduling sheet when work has been completed.
Paper/pencil tasks used in math exploratories.	Include math activities - math bingo.	More hands-on tasks are included.

Follow Up: An observation of XX's class has been scheduled for November 13.

Figure 4. Sample monthly training log.

This figure is taken from Wang, M.C., and Gennari, P. Analysis of the design, implementation, and effects of a Data-Based Staff Development Program. Journal of Teacher Education and Special Education, 1983, in press.

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Staff development plans are reviewed periodically by school personnel (e.g., education specialists and/or principals) to determine the appropriateness of planned training objectives and to monitor progress toward achievement of the objectives. In addition to these periodic reviews, when staff development plans for each school are updated and revised if needed, formal reviews of the plans are scheduled following each of the three periods for collecting degree of implementation data.

Monthly training logs kept by education specialists, or other school personnel who are responsible for ongoing training and program monitoring, are a major source of information for each school and for individual teachers. The logs include descriptions of implementation related behavior; specific strategies for improving the degree of implementation (e.g., classroom observations, conferences between teachers and education specialists, in-service training workshops); expected outcomes; and follow-up activities. Information from the monthly training logs, combined with results from analyses of the degree of implementation data, is used to update staff development plans on a continuing and regular basis.

The Data-Based Staff Development Program has been field-tested in conjunction with the implementation of the ALEM in schools that vary widely in terms of ethno-cultural/socioeconomic characteristics and geographic locations (Gennari & Wang, 1982; Wang, 1981c; Wang, Nojan, Strom, & Walberg, 1983). The overall results suggest that a training program which is based on actual implementation needs does make a difference. Results from analyses of the efficacy of this particular data-based approach to personnel preparation point to the following major findings:

1. Measures of degree of implementation are useful in identifying staff development needs for improving program implementation.

2. Significant changes in the degree of implementation occur for specific program dimensions that are the target of systematically designed staff development activities; conversely, very little or no improvement tends to occur in the implementation of critical dimensions for which the data indicate training is needed but none is actually prescribed or operationalized.

3. Improvements in degree of implementation scores also result in improvement in the quality of classroom processes and student learning outcomes.

4. Classrooms with different degrees of implementation are significantly different in terms of classroom processes and student learning outcomes.

5. Significant differences are found in the degree of implementation scores for ALEM and non-ALEM classrooms, especially when the critical dimensions associated with the more generic qualities of effective instruction are considered.

Since investigations of its efficacy have been conducted only in the context of implementation of the ALEM, the generalizability of this data-based approach to staff development is yet to be established. Nevertheless, some essential characteristics of effective personnel preparation efforts have been identified as a result of initial field testing and implementation. These include systematic integration of training objectives and activities with the classroom implementation of instructional components and objectives, availability of assessment procedures and instruments for certifying the presence or absence of specific program features, utilization of a diagnostic approach to analyze and monitor program implementation, inclusion of a data-based system for identifying staff development needs, incorporation of clearly defined procedures for training and feedback, and involvement of all relevant school personnel in the identification of staff development objectives and the planning of training activities.

Implications for Future Developments in Teacher Training

The design and content of a teacher preparation program for implementing adaptive instruction is predicated not only on the need for reconstructing general and special classroom instruction, but also on the need for concomitant changes and refinement in the approach to teacher preparation. The specific components of the training program discussed in this module are based on the fact that major changes must be made in teacher development and in schools themselves if the overall goal of providing effective schooling for each student is to be realized.

Widespread implementation of the kind of field-based approach to personnel preparation discussed here dictates the adoption of a delivery system that involves the collaboration of many professional groups including local school district personnel, faculty of colleges of education, and developers of innovative practices and programs.

Therefore, the next step for further development in this area ideally would be the development of training programs that integrate information-based courses on theory and research with field-based demonstrations of implementation practices. Attention should be given to the needs and interests of practitioners, as well as to the establishment of school-based demonstration capabilities, in the provision of a continuum of pre-service and in-service training activities. As noted previously, school-based demonstrations of effective schooling practices and educational innovations serve several important functions that information-based training programs are not designed to meet. A viable alternative is the establishment of school-based demonstration and training centers developed through active collaboration between teacher training institutions and local school systems. The major anticipated outcome of such a collaborative venture is the operationalization of alternative ways to manage available educational resources so that congruence can be achieved between the professional development needs of school personnel and the professional education opportunities which teacher education programs are designed to provide. Other outcomes would include increased opportunities for demonstrating the possibility of translating theoretical and philosophical ideas, as well as research findings, into basic tools for school improvement and dissemination of innovative and improved practices; and increased receptivity of school personnel to innovative practices. The modeling of new educational possibilities and the display of salient features of successful programs through school-based demonstration and training centers can effectively disseminate information about the utility, implementability, and efficacy of specific innovative practices.

This call for a major restructuring of teacher education programs is based on the contention that the skills required for effective implementation of innovative concepts and practices, such as adaptive instruction, cannot be acquired without providing trainees with firsthand observations of how innovative practices are operationalized and integrated into extant programs. Under ideal situations, faculty of colleges of education would not only include adaptive instruction in present teacher education programs, but would also seek collaboration of local schools to jointly design and implement a demonstration-teacher training program. Implementation of the model described here is, realistically, a long-range goal. However, some intermediate steps can be taken to restructure present training programs. Creatively adapting to existing constraints and refining the objectives of teacher education programs are necessary first steps.

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Related Articles

The following articles are particularly relevant to the topics discussed in this module.

THE SCHOOL OF THE FUTURE:
ADAPTIVE ENVIRONMENTS FOR LEARNING

Robert Glaser

Learning Research and Development Center

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The School of the Future: Adaptive Environments for Learning

ROBERT GLASER

INTRODUCTION AND OVERVIEW

I believe that education is undergoing a significant transition from one mode of education to another. This change is not being brought about by abstract writings and polemics about educational reform. Rather, it is being accomplished by those involved in the actual design of educational environments and those involved in providing research and development in support of practical educational design. Individuals in our schools who seek to maintain old-fashioned systems will lose out to those who are attempting to understand the nature of the new education that society demands, and that new concepts about human nature recommend. The change in education that I believe is taking place is what I shall attempt to describe here. If the nature of this transition can be spelled out with any clarity, then perhaps we can do a better job of moving to where we think we should be going, and along the way we can assess our effects, suggest what new knowledge seems to be required to get there, and change our directions accordingly. In my comments I will attempt to describe where we have been and where we are starting to go, and then, in general terms, to describe the characteristics of schools that are necessary to meet the challenge of these new directions.

SELECTIVE AND ADAPTIVE MODES OF EDUCATION

To begin, I will contrast, in a somewhat overstated way, two kinds of environments. One I shall call a selective educational mode, and the other, an adaptive educational mode. Traditionally, a selective educational mode has been predominant; today, however, we aspire to an adaptive mode of education.

Selective Mode

The prevalent selective mode of education is characterized by minimal variation in the conditions under which individuals are expected to learn. Few instructional options are provided, and a limited number of ways to succeed are available. Consequently, the adaptability of the system to the student is limited; alternative paths for students with different backgrounds and talents are restricted. In such an environment, these fixed and limited paths require particular student abilities, and it is these particular abilities that are emphasized and fostered to the exclusion of other abilities. In this sense, the system is selective with respect to individuals who have particular abilities for success—as defined by the system, and as it can be attained by the means of instruction that are available. The effectiveness of the system is enhanced by admitting only those students who score high on measures of the abilities required to succeed. Furthermore, since only those students who have a reasonable probability of success are admitted and retained, little change in the educational environment is necessary, and the differences among individuals that become important to measure are those that predict success in this special setting.

A selective educational mode operates in a Darwinian framework, requiring that organisms adapt to, and survive in, the world as it is. The problem with this mode of education is that a wide range of potential capabilities and talents might be lost because of the exclusive reliance upon selection for survival in a particular and relatively fixed setting. An alternative, however, is that the environment can be changed.

Adaptive Mode

In contrast to a selective mode, an adaptive mode of education assumes that the educational environment can support many and varied instructional methods and opportunities for success. Alternate means of learning are adaptive to, and are in some way matched to, knowledge about each individual—his background, talents, and interests, and the nature of his past performance. An individual's styles and abilities are assessed either upon entrance or during the course of learning, and certain educational paths are elected or assigned. Further information is obtained about the learner as learning proceeds, and this, in turn, is related to subsequent alternate learning opportunities. The continual interaction between performance and the subsequent nature of the educational setting is the defining characteristic of an adaptive mode. The success of this adaptive interaction is determined by the extent to which the student experiences a match between his specific abilities and interests and the activities in which he engages. The effect of any election of, or assignment to, an instructional path is evaluated by the changes it brings about in the student's potential for future learning and goal attainment. Measures of individual differences in an adaptive educational mode are valid only to the extent that they help to define alternate paths that result in optimizing immediate learning, as well as long-term success.

When a selective educational mode is compared with an adaptive one, one must ask whether the particular selective tests and sorting devices that are part of present schooling fail to consider abilities and talents that might emerge as important in a more interactive setting where there is room for matching abilities and modes of learning.

In any educational mode, then, the individual differences that are particularly important are those that have ecological validity within a particular educational system. In our traditional selective educational mode, the individual differences that are measured in order to make educational assignments center around the concepts of intelligence and aptitude. For a moment, let's look into these.

INTELLIGENCE AND APTITUDE

Of the various attempts to measure intellectual ability that began at the turn of the century, Binet's work from France emerged strongly.

It was a practical endeavor to predict school success. The Minister of Public Education supported Binet's attempts to determine what might be done to insure the benefits of instruction to retarded children. It was decided that children suspected of retardation be given an examination to certify that, because of the level of their intelligence, they were unable to profit from instruction as given in ordinary schooling. For this purpose, Binet designed a test that was predictive of scholastic success in an essentially fixed educational mode. To be fair, Binet's writings do indicate a great deal of sensitivity to the possibilities for individual differential diagnosis.

Nevertheless, the validation of a test is a very specific procedure in which individuals are exposed to particular kinds of test items that are constructed to predict a particular criterion measure. No test is simply valid in general, but rather for a specific purpose and a particular situation. The concept of Binet's work has persisted, and it has been pointed out that: "Current tests differ from those of the earlier generation just as 1970 automobiles differ from those of about 1920: more efficient, more elegant, but operating on the same principles as before." [1]

What I am suggesting then is that the human performances we identify with the words "general ability," "scholastic intelligence," and "aptitudes" have emerged from measurement and validation procedures in an educational system of a particular kind. And because our educational system provides a limited range of educational options for adapting to different individuals, these general abilities override the influence of any more specific abilities and talents that might be additionally useful if alternate ways of learning were available.

Perhaps the following analogy is useful: In the old days, when the bacilli contributing to tuberculosis were relatively widespread so that the general level of exposure was uniformly high, hereditary predisposition was a major variable contributing to contracting the disease. If one's parents had tuberculosis, it appeared that one was more prone to get it. In modern times, exposure to the bacilli is under control and less widespread, and the more significant variable in contracting the disease now is not one's family history but whether or not one has actually been exposed to the germ. As the situation changed, the factors contributing to survival changed. Perhaps similarly, as school environments change, the predispositions required for survival in the new environment will be different from the old. The individual differences or their relative weights that were important to measure in one setting may be different in another; and new capabilities may need to be assessed in the educational context of a new setting.

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[1] L. J. Cronbach, *Essentials of Psychological Testing*, 3rd ed. (New York: Harper & Row, 1970).

Cognitive Processes

What kinds of capabilities and talents am I talking about? Consider as an example cognitive learning in the primary grades.[2] In the first grade of elementary school, children are taught beginning reading and arithmetic, and some attempts are made to accommodate individual differences: general intelligence, slow and fast learners, impaired and unimpaired learners, and advantaged and disadvantaged children. The job is a difficult one; consider what is asked of the child in currently popular mathematics programs. He or she initially must learn to count accurately a number of objects (usually from one to ten), represent them with symbolic notations (numerals), and understand that the numeral "2" represents a specific quantity that is greater than "1" and less than "3." Children then are taught to implement addition and subtraction algorithms using these numerals. Implicit in performing these tasks are very specific prerequisite visual-motor and spatial-perceptual abilities, in which a child must be reasonably competent before he or she can begin to learn the tasks the curriculum requires. Similarly, learning to read requires auditory information-processing abilities. The child must recognize that spoken language consists of organized series of phonemic elements (phrases, words, sounds) that interrelate in a specific way, and then learn to analyze spoken words into their component sounds as they are represented by the letters of the alphabet. Competence in these basic auditory and visual perceptual skills is required as a necessary prerequisite for adequate learning.

Traditionally, a selective mode of education would, for the most part, sort out advantaged from disadvantaged children on the basis of their competence in these skills. Their different capabilities would be accepted as givens that classify groups of children and differentially predict their probable future achievement. In contrast, an adaptive educational mode would require detailed analyses of these skills so that teaching procedures could be adjusted to a child's prerequisite abilities, or so that competence in these prerequisite skills could be taught by

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2. J. Rosner, "Language Arts and Arithmetic Achievement, and Specifically Related Perceptual Skills," *American Educational Research Journal,* 1973, *10*(1): 59–68.

specially designed curricula. This has been done in recently published perceptual skills curricula (for example, Rosner, *Perceptual Skills Curriculum*, New York: Walker Educational Book Corporation, 1973). The effectiveness of these programs provides strong evidence that teaching various aspects of these basic abilities to children who need them enhances their success in beginning arithmetic and reading.

The strategy of such programs is to develop basic readiness skills and aptitudes, such as auditory and visual processes, rather than to merely classify children as deficient in these areas as a result of inadequate background and upbringing. Armed with competence in these abilities, children can then proceed with the higher-order learnings involved in reading and elementary number concepts. This process of adapting instruction to what the learner can do, or improving learning processes so that he or she can profit more fully from available instruction, is the fundamental notion of the adaptive mode of education.

Consider another example, this time in higher education, on which some laboratory research is actually being carried out.[3] We know that the scholastic aptitude tests taken by high school students are predictors of success in early college years. Two major aptitudes measured are verbal ability and quantitative ability. In an adaptive educational setting we would like to know more about these abilities so that this information can influence our teaching. Such information could be obtained by taking a group of students and classifying them as high and low in terms of these abilities, then studying the cognitive abilities of the individuals in each group. This would be done in order to determine the characteristics of high verbal and high quantitative ability students in terms of what we know about cognitive processes and current information-processing theories of memory and cognition. If such cognitive processes could be identified, then the implications for instruction would be more profound than the present correlationally derived psychometric relations between validated aptitude measures and school performance. Clues could be made available about how verbal and quantitative abilities might be modified or employed for learning. Research of this kind could lead to the assessment of human performance in a way that could move the usual psychometric predictions from static statements about the probability of success in school to dynamic statements about what could be done to increase the likelihood of success. For this purpose, we would need to carry out studies that attempt to identify the kinds of processes required by various school tasks and to characterize how different individuals perform them. Following this, the conditions required to learn a task could then be adapted to individual characteristics, or the individual might be taught how to engage more effectively in the processes involved.

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[3] E. Hunt, N. Frost, and C. Lunneborg, "Individual Differences in Cognition: A New Approach to Intelligence," in *The Psychology of Learning and Motivation*, ed. G. H. Bower (New York: Academic Press, 1973).

Cognitive Style

Adaptation in education is not necessarily restricted to the cognitive abilities that I have just described; also involved is what we loosely refer to as cognitive style. For example, when first grade children are placed with experienced teachers who have a reflective style, the children become more reflective during the school year than children who are placed with impulsive teachers.[4] The practical implication of this finding for school instruction suggests tailoring the tempo of the teacher to the tempo of the child so that, for example, the behavior of the impulsive child is influenced by the presence of a reflective teacher model.

The processes that make up cognitive style are important to consider in adapting education to children from different cultures. As we know, early experience in a particular cultural environment provides the child with a set of values and a set of techniques and skills for learning to learn and for processing incoming information. It has been frequently pointed out that in our society, the middle class child acquires these things so that they are continuous with what will be required of him in school, whereas what a lower socioeconomic class child acquires may be discontinuous with what school generally demands. In a selective-nonadaptive environment for learning, "cultural deprivation" is defined in terms of a set of experiences that establishes a discontinuity between preschool experiences and school requirements. In the adaptive educational environment that I envision, it would be assumed, as a matter of course, that the values, styles, and learning processes that the child brings to school are of intrinsic worth. These modes of behavior have, in fact, been extremely functional in the child's environment, and an adaptive setting would accept these assets of the child's functioning as a basis for a program of education.[5]

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[4] R. M. Yando and J. Kagan, "The Effect of Teacher Tempo on the Child," *Child Development*, 1968, *39*: 27-34.

Classification versus Adaptation

As I have said, our prevailing selective mode of education, strongly influenced by the aptitude test tradition, has been uniquely oriented toward the prediction of successful performance in established educational or working environments. Aptitudes as measures of individual differences have taken on meaning in terms of their predictive validity for specific purposes and in specific situations. By virtue of the way in which they have been operationally defined, aptitude measures have primarily this purpose for education. This is made strikingly apparent by the fact that one finds very few studies on the training and modifiability of psychometrically defined aptitudes and abilities. In contrast, Piagetian and other cognitive definitions of intelligence have stimulated a plethora of research on the effects of instruction. These cognitive theories have not been concerned with differential prediction, but instead with changes in processes that influence performance and, hence, suggest specific processes on which to focus instructional attention.

From the viewpoint of adapting instruction to individual differences, most of the work carried out in the selective-psychometric tradition is frustrating. A set of measurements shows that one individual is worse than another on some performance that is predictive of the performance on a criterion task, so some purpose is served for selection. However, no strong basis is provided for doing anything about the performance. The measures obtained do not tell how the individual might be educated to improve his performance, or how the situation might be changed to facilitate achieving criterion performance.

A major emphasis of the selective mode of education has been the establishment of aptitude tests or other assessments as predictive entities. Basically, the technique employed is to obtain some initial assessment of current performance that is predictive of the later outcomes of schooling. This is done under the assumption that the intervening educational process is fixed enough to require primarily the talents assessed by the initial measure of performance. The tactic is unduly classificatory, unduly assuming of only one way to get an education, and not error free in that it can fail to account for other talents that enable an individual to get through school and that are correlated with success beyond school.

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[5] See J. W. Getzels, "Pre-school Education," *Teachers College Record,* 1966, 68: 219–228.

Our penchant for a fixed educational mode arises in part from an old-fashioned psychology, from the scientific and social tendency to think in terms of fixed categories of human beings with consistent drives and dispositions.[6] In contrast, current thinking views human beings as highly responsive to the conditions around them so that as conditions change or conditions are maintained, individuals act accordingly. Adaptive educational environments can take advantage of the fact that individuals show great subtlety in adapting their competencies to different situations, if the situation permits such adaptability. Individuals do show generalized consistent behavior on the basis of which we frequently characterize them, but they also are good at discriminating and reacting to a variety of experiences in different ways. The traditional measures of general ability and aptitudes err on the side of assuming too much consistency and deemphasize the capability of individuals to devise plans and actions depending upon the rules, needs, and demands of alternative situations. If, in our thinking about individual differences, we make as much room for the capacity of individuals to adapt and change, as well as to be stable, and as much room for the capacity for self-regulation and self-development, as well as for victimization by enduring traits, then an adaptive notion of education must follow.

An educational system, as Tyler suggests, should present alternative environments that enhance the ability of the individual for self-regulation in different situations. The design of adaptive environments is a key problem in educational reform and is a difficult shirtsleeve task. How can a school environment be designed so that it is responsive and sensitive to the performance of a learner? How can a learner change plans and regulate his actions as a function of the information he receives? How are testing and assessment activities to be interpreted, not as intractable evaluation devices, but as procedures that provide information to suggest alternative courses of action? "Breaking out of the current confines of schooling"—the sterile cry of many educational reformers—is to be interpreted constructively as the design of environments that are flexible enough to provide the give and take that is necessary for optimizing cognitive growth and competence. This requires changes in the current nature of schooling, and the design of such environments is the major challenge that is emerging.

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[6] W. Mischel, "Continuity and Change in Personality," *American Psychologist,* 1969, *24:* 1012–1018; idem, "Toward a Cognitive Social Learning Reconceptualization of Personality," *Psychological Review,* 1973, *80*(4): 252–283.

DESIGN OF AN ENVIRONMENT FOR ADAPTIVE EDUCATION

Let me turn to this challenge. It must be recognized at the outset that I am convinced that the job cannot be done by practicing educators alone; they must do it in the context of a special relationship between practice and research, between education and the sciences and disciplines relevant to it. Scanlon's propositions in chapter four, I believe, are germane in this regard.

The stance for the application of research to education seems quite clear at this time. The impact of research on education can no longer be viewed as a linear progression from the discovery of knowledge to innovation, but rather as a complex set of mutually dependent activities. The sequence from basic research, to applied research, to development, to practice and application, on which most of us were weaned, seems no longer applicable if, in fact, it ever was. While it has been axiomatic that practice can feed on research, it now must be recognized that research, in turn, feeds on and is often invigorated by the requirements of practice. The coupling between these two elements is far closer than many of us have realized. The close coupling of research and practice in education carries with it a self-correcting mechanism whereby failures in practice can encourage fundamental research. An interactive mode of operation between application and applied and basic research is what I would like to encourage for education. While I cannot deny the importance of undirected basic research, neither can I deny the importance of the intuitive design of educational practices by outstanding teachers. Good practice has an artistry and intuition that must not be restricted, and that may far outrun any momentary attempts at scientific understanding and analysis. However, ideally, the job of educational research is to work within these two extremes, contributing to knowledge and practice and trying to understand both without inhibiting either.[7]

More to the point, what are some of the emerging general requirements for adaptive educational environments? In a very brief answer to this question, I will touch on four points: teaching and curriculum, student self-management, open testing and assessment, and instruction in basic intellectual processes.

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[7] See R. Glaser, "Educational Psychology and Education," *American Psychologist*, 1973, *28*(7): 557–566.

1. Teaching and Curriculum. The conventional boundaries of grade levels and arbitrary time units for subject matter coverage need to be redesigned to permit each student to work at his or her actual level of accomplishment and in the context of his or her particular competencies. The student should, if desirable, be enabled to move ahead as soon as prerequisites that foster a new level of learning are mastered.

In order for the student and the teacher to assess student progress and development and place the student at a level of achievement that he or she finds motivating, curricula must be analyzed in terms of sequences of progressive stages of accomplishment so that guidelines can be established for setting up a program of study. A student's "grade level" in school can be defined in terms of a stage in this progression of observable growth.

A student's progress through the curriculum progression must be adequately monitored by assessment measures and observational judgment by the teacher so that the student's performance dictates the design of a teaching program adaptive to individual requirements. There is something to be said, in this connection, for Boulding's apprehensions regarding present assessment procedures. The school environment is continually adapted to each student rather than adjusted only to those students who appear to be "making it." Teachers and other school personnel must be provided with special professional training and assistance so that they can carry out the evaluation, diagnosis, and decision making required for the guidance of individual student performance as contrasted with the management of learning for a total class.

An important requirement for adaptive education is the design of flexible curricula with many points of entry, different methods of instruction, and options among instructional objectives. Extensive sequential curricula that must be used as complete systems, and into which entry at different points is difficult, should give way to more "modular" organizations of instructional units. This does not imply the abandonment of sequence requirements inherent in the structure of the material to be learned, but does imply that prerequisites, where essential, are to be specified in terms of capabilities of the learner rather than in terms of previous instructional experiences or exposure. A flexible curriculum avoids the necessity for all individuals to proceed through all steps in a curriculum sequence, but accepts the fact that some individuals acquire prerequisite information and skills on their own, while others need more formal support to acquire the prerequisites for more advanced learning. In such a system it should be easy to incorporate new and varied instructional materials and objectives as they are developed in response to the changing educational interests and requirements of both teachers and students.

2. Student Self-management. Because an essential part of adapting the environment to the capabilities of the learner involves adjustments made by the learner himself, students must acquire increasing competence in self-directed learning. To accomplish this, the school must provide students with models and standards of performance so that they can evaluate their own attainments and select teaching activities (with or without the help of teachers and peers) as a function of their increasing competence. Experience has shown that children in elementary school can modify the environment for their own learning requirements if they command or are taught the skills to do so. For this purpose they can be taught how to search for useful information and how to order and organize it for learning and retention. In the selection of content for the elementary school, preference can be given to information and skills that maximize the possibilities for learning new things. The orientation and attending skills of children can be encouraged so that they learn to identify the relevant aspects of tasks and can attend to them with little distraction. With such information and skills, children, as active learners, can help guide the process of adaptive education.

3. Open Testing and Assessment. Adapting instruction to an individual student requires that the teacher and the student attend to and utilize detailed information about student performance in order to make appropriate instructional decisions. To assist in this process, tests and information from other sources will need to be developed to describe competence in a more clear-cut and absolute way than is usually the case with relativistic grading procedures where test scores take on meaning only in terms of the relative standing of students.

This requirement will result in an increased emphasis on open testing and behaviorally indexed assessment. In an adaptive environment, tests designed primarily to compare and select students will play a decreasing role because access to particular educational activities will need to be based on the student's background interests and prerequisite competence. Tests will have an intrinsic character of openness in that they will serve as a display of competence to be required, and the results will be open to the students, who can use this knowledge of their performance as a yardstick of their developing ability. These tests also will assess more than the narrow band of traditional academic outcomes. Measures of process and style, of cognitive and noncognitive development, and of performance in more natural settings than exist in the traditional school will be required. Fortunately, this trend in process-oriented, broad-band assessment is now discernible in many new efforts.

4. Basic Intellectual Processes. The teaching of basic psychological processes is also required, as I have indicated throughout my remarks. We have assumed for too long the stability of "basic aptitudes"; now we need to determine how these talents can be encouraged and taught. This means that what is taught in school should involve the teaching of the processes involved in intelligence and aptitudes, as well as subject matter knowledge and skills.

CONCLUSION

To conclude, an adaptive environment assumes that there are many ways to succeed and many goals available from which to choose. It assumes that no one particular way of succeeding is necessarily valued over another. In our current selective environment, it is quite clear that the way of succeeding that is most valued is within the relatively fixed system provided. Success in society is defined primarily in terms of the attainment of occupations directly related to the products of this system. However, if an adaptive mode becomes prevalent and wider constellations of human abilities are emphasized, then success and achievement will need to be differently defined; and many more alternative ways of succeeding will need to be appropriately rewarded than is the case at the present time.

EDITORIAL COMMENTARY

Conceiving of the school of the future as one characterized by adaptability, Glaser begins by telling us that hard work, not diatribes and wishful thinking, will take us to our goals. Differing somewhat from the other theorists, he views the future as something that must of necessity evolve out of the present, and he believes, therefore, that we must begin with the pervasive weaknesses in the present learning environment. The shoring-up of these deficiencies, he argues, is a vital and indispensable step in achieving the kinds of schools we will need. Summed up, the heart of the transition he envisions lies in shifting from a selective educational mode to an adaptive one.

Because Glaser is not only a researcher but a developer and administrator as well, he demonstrates a keen appreciation of the complex sequence of events through which good ideas are translated into good practice. Recognizing that high ambitions alone are not enough, he describes for us not only the goal but also the interim progressions that must occur before the goal can be realized.

Some time ago, in a lively essay, Donald Schon described the processes through which intellectual fashions help to mobilize action.[1] *In so doing, he distinguishes between the roles of creative thinkers who generate and promulgate new ideas; idea brokers who function as intermediaries and carriers; prestigious groups and institutions that give the ideas respectability and draw them to the attention of the media; the dissemination role of the mass media itself; and, finally, the informal communication networks—in invisible colleges—that spread the ideas and bring them into good currency. In short, valuable ideas must be invented, championed, diffused, put to test, and incorporated into conventional thought. In connection with these requirements, and the transition they embody, Glaser contends that: "If the nature of this transition can be spelled out with any clarity, then perhaps we can do a better job of moving to where we think we should be going, and along the way we can assess our effects, suggest what new knowledge seems to be required to get there, and change our directions accordingly."*

The critical factor, in his distinction between the selective and

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[1] *Donald A. Schon, "Maintaining an Adaptive National Government," in* The Future of the United States Government: Toward the Year 2000, *ed. Harvey S. Perloff (Englewood Cliffs: Prentice-Hall, 1971).*

adaptive modes, is that of reversing the accommodation process. Because the selective mode is fixed, incapable of responding to human difference, the learner must make whatever adjustments are necessary to fit the established mold. The adaptive mode, in contrast, inverts the process so that the system *accommodates to the child. Rigid in structure, the selective environment minimizes variation, limits spontaneous response, and—in its greatest defect—places exaggerated emphasis upon some learning abilities and excludes other, equally valuable, ones.*

Glaser's adaptive mode, on the other hand, provides for a continuous interplay between the learner and the learning environment. An infinitely larger number of responses are possible, alternative learning routes exist for each instructional goal, and, in general, learning and instruction are tailored to the child's natural style and talents. "The individual differences that are particularly important," Glaser writes, "are those that have ecological validity within a particular educational system." Hence, the point in identifying individual differences among learners is neither comparison nor assessment, but determination of the particular conditions that must be present in the instructional setting.

When we speak of such matters as "general ability," "scholastic intelligence," and "aptitude," he contends, we have in mind specific kinds of learning in the instructional system now in use. But, because the present system has limited range and flexibility, preoccupation with these general abilities causes us to overlook and ignore other important abilities and talents that could be nurtured with considerable profit in a system of greater elasticity and adaptability. The benchmark of an adaptive environment, therefore, lies in its responsiveness; the system, in short, can be bent and shaped to fit the learners' particular psychological complexion.

Glaser's method of dealing with the future, then, is to attack, foursquare, the major inadequacies in our present teaching methodology. Thus he would agree, presumably, with Tyler's, Scanlon's, and my own arguments—each of which opts for a problem-centered approach to the future. And, like Bell, Glaser regards the current intoxication with natural, unstructured learning experience as heavily suspect. Despite these suspicions, however, he is anything but a defender of the status quo; acknowledging the great need for educational reform, he believes simply that hard work and constructive action will bring more good than sterile oratory or romantic wishfulness.

Not so very long ago, the Institute for the Development of Educational Activity, a division of the Charles F. Kettering Foundation, established the National Commission on the Reform of Secondary Education. After a lengthy period of study, the Commission set forth a series of *recommendations in a report called* The Reform of Secondary Education. *Many of these recommendations tend to reinforce Glaser's convictions with respect to the indispensable conditions for change. Consider, for example, the following*[2]*:*

Recommendations for Improving Secondary Education

> *The reform of secondary education cannot be accomplished by educators working alone. It requires the ingenuity and assistance of many people in the community served by a particular school. The recommendations of the Commission must be considered in this framework.*

Community Participation in Determining Secondary School Expectations

> *Schools will not be able to achieve their purposes without increased help from the people in the communities they serve. Communities must participate in the formulation of goals and in continuing efforts to refine and adapt the statements of goals and objectives. The communities as a whole, not solely the subsection called schools, must achieve the goals.*

Teacher Training

> *Teacher training institutions should revise their programs so that prospective teachers are exposed to the variety of teaching and learning options in secondary education. New teachers should be able to work in several instructional modes. Extensive in-service programs should be instituted to retrain teachers presently employed to equip them with a greater variety of approaches and skills. This need will become increasingly acute as the decline in birth rate encumbers the schools with aging teaching staffs.*

Bias in Counseling

> *Counselors should ensure that all students, regardless of sex or ethnic background, are afforded equal latitude and equally positive guidance in making educational choices.*

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[2] *Reprinted with permission from* The Reform of Secondary Education: *A Report to the Public and the Profession by the National Commission on the Reform of Secondary Education. McGraw-Hill, 1973, pp. 13–22.*

COMMENTARY

Alternative Paths to High School Completion

A wide variety of paths leading to completion of requirements for graduation from high school should be made available to all students. Individual students must be encouraged to assume major responsibility for the determination of their educational goals, the development of the learning activities needed to achieve those goals, and the appraisal of their progress.

In outlining, for us, the structure of an adaptive environment, Glaser describes three specific essentials that define its basic character. In the first of these, cognitive processes, there must be a deliberate effort to build in whatever prerequisite skills are vital to the learning goals. In the existing scheme of things, for example, aptitudes are regarded as immutable and children are stereotyped according to their test profiles. What we must now begin to do, in the way of remediation, is to design curricula that augment and extend aptitudes. Glaser's demand, put bluntly, is that we begin to face our problems rather than avoid them: Basic readiness skills are learnable and therefore teachable. "This process," he says, "of adapting instruction to what the learner can do, or improving learning processes so that he or she can profit more fully from available instruction, is the fundamental notion of the adaptive mode of education."

Similar revolutions, it might be added, can also occur in higher education. Rather than use verbal and computative abilities to assess and categorize students, we could explore the nature of different cognitive processes more fully, increase our grasp of learning theory, and eventually design instructional programs that are tailored to the individual's aptitudes, and to the particular conditions that assure success in schooling. "Research of this kind," Glaser contends, "could lead to the assessment of human performance in a way that could move the usual psychometric predictions from static statements about the probability of success in school to dynamic statements about what could be done to increase the likelihood of success." Like many other critics who find considerable fault with what now goes on, he believes that we can indeed have schools without failure; Glaser's solution, however, is neither escapism nor settling for easier standards, but rather guaranteeing success by improving the system's adaptability and the learner's capability.

There are, from the standpoint of practitioners, far-reaching implications to his constructs. Grading, for example, no longer would be used to divide the strong from the weak. Assuming that appropriate *methodology and resources were available, schools would be expected to achieve acceptable levels of learning with virtually every student. Moreover, since all children do not learn in the same way, teachers would be obliged to master a repertory of alternative instructional techniques with which to accommodate the particular idiosyncrasies of the particular student.*

The second essential of Glaser's adaptive mode involves cognitive style. His quest is that of "matching the tempo of the teacher to the tempo of the child." What this would require is a reversal in format: instead of youngsters adapting to the school, school would adapt to youngsters. We no longer would devote ourselves to the fruitless search for "culture free" curricula; rather, we would fashion a defensible curriculum around the child's own cultural inheritance. In the educational environment Glaser foresees, "it would be assumed, as a matter of course, that the values, styles, and learning processes that the child brings to school are of intrinsic worth." He seeks, consequently, to respect individuality both in content and in learning habit.

Here, again, the implications for practice are substantial. It will be necessary to invent procedures through which maximum "fit" between teacher and student personality can be achieved. Instructional tactics suitable to different student learning styles will need to be devised. And the range of subject matter itself will need to be made sufficiently broad to incorporate the child's cultural experience.

The third essential of Glaser's proposed system involves adaptation in lieu of classification. His basic thesis is that existing aptitude measures are used primarily for differential prediction—that is, to predict probable learning success. They provide few clues, however, as to what might be done to improve success. Moreover, four additional defects of current aptitude-measuring devices cause him to worry about their potential destructiveness to children: first, they unjustly sort students into fixed categories; second, they are based upon a unitary conception of learning, ignoring the fact that an instructional objective can be accomplished in many different ways; third, the classifications themselves are highly subject to error; and, fourth, the process slights the vast range of human talents not covered by the particular classification device.

Glaser's corrective, logically, is to devise and utilize measurement systems that are diagnostically comprehensive, and that permit the school to understand and subsequently nurture each learner's special nature. Humans, Glaser argues, have a sublime capacity to adapt when they are not constrained by excessive restrictions. Sharing Benjamin Bloom's be-

lief that stability can exist amidst change, he opts for a school that is concerned less with consistency and more with plasticity. Such a postulation, self-evidently, is fraught with operational clues. Through in-service activities, teachers must be helped to recognize that their students are of different temperaments and dispositions; it may be necessary to develop instructional exercises that enhance the child's inherent ability to adapt; and, of greatest importance, we must set to work designing alternative educational environments that can free the child from unilateral programming and systemic rigidities. Glaser tells us, however, that these objectives are not easily come by. They are unavoidably, he says, "a difficult shirtsleeve task."

In the latter portion of the article, Glaser makes clear his reservations regarding many of our present research and development procedures. His contention is that definitive reform must occur before an adaptive program of education can be brought to fruition. "It must be recognized at the outset," he writes, "that I am convinced that the job cannot be done by practicing educators alone; they must do it in the context of a special relationship between practice and research, between education and the sciences and disciplines relevant to it." His call, therefore, is for a new alliance among social scientists in general, and the users of those sciences in particular. Reinforcing a conviction of Atkin regarding the importance of practitioner-oriented research,[3] *Glaser argues: "The sequence from basic research to applied research, to development, to application, on which most of us were weaned, seems no longer applicable, if, in fact, it ever was." Our need, he believes, is to fashion a much closer interplay between scholarly inquiry and practical implementation. His predominant fear, one might conjecture, is that—without better interaction and sharper focus—we will continue to experience insurmountable difficulties in bringing the fruits of research to bear upon customary practice.*

There are, then, direct parallels between Glaser's propositions and those outlined by Scanlon. Both agree that real-world problems should stimulate basic research, and that the consequent findings must be conjoined with insights stemming from the intuitive hunches of practitioners. The collaborative synergy Glaser seeks, it might be added, probably will require a good deal of cultivation; one suspects, for example, that while many practitioners will welcome an opportunity to work with empa-

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[3] *J. Myron Atkin, "Grass Roots Change and Informal Methods," in* Studies in Open Education, *ed. B. Spodek and H. J. Walbert (New York: Agathon Press, 1974).*

thetic basic researchers, they will have to be convinced that the partnership is authentic and that they are not once again being used as human substitutes for the guinea pigs and rats in laboratories.

The essay closes with an explication of four research and development requirements that must be met before an adaptive learning environment becomes reality. The first of these has to do with a more resilient instructional organization. The conventional boundaries of grade and time must be loosened, the curriculum must allow for multiple points of entry, and teaching must become more a matter of guiding individual growth than of mechanical classroom management.

The second requirement concerns student autonomy. Glaser sees no real reason why self-directed student learning cannot become common practice. Given proper models and standards of performance, children can learn the skills of personal evaluation, subject matter selection, and task analysis. There is, in point of fact, some evidence that in the best of our "open" classrooms such things do go on successfully. Glaser's hope, therefore, is that research and development can be directed toward the fabrication of instructional programs that make it profitable for all teachers to work in this way.

His third requirement strikes directly at the deficiencies of our present testing practices. We must, Glaser reasons, put an end to tests that do no more than indicate relative standing; we must eliminate measures designed primarily to sort children according to preconceived criteria; and, importantly, we must learn to appraise the far more delicate phenomena of learning style, noncognitive development, and teaching in natural settings. Finally, in the fourth requirement, we must increase our capacity to deal with basic aptitudes themselves. Intelligence and ability, Glaser believes, are not determined in heaven alone. They can—if we but could discover how—be bred and refined.

These four requirements, thoughtfully conceived, are useful in pointing the way to educational research that anticipates the educational tomorrow. As such, they bring to mind other recent efforts to distinguish between sane and insane endeavors. For example, a study on future-oriented educational research, conducted by the Stanford Research Institute, yielded somewhat similar prescriptions.[4] The study considered (a) chronic problems, (b) chronic problems possibly becoming acute, (c) acute problems, and (d) adaptive problems. The following goals, contained in a report to the National Institute of Education, are illustrative:

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[4] "The National Institute of Education: Working Papers on Problems, Goals and Program Initiatives for NIE." A Research Note by O. W. Markley (Educational Policy Research Center, Stanford Research Institute, 1972), Section 2, pp. 10–13.

CHRONIC PROBLEMS

Broad Conflict over Goals, Practice, and Nature of Education

To develop an informed educational statesmanship in order that much of the conflict can take place in the political and public arena rather than in the schools themselves.

To create sufficient diversity in order that the different needs of different groups can be met without destructive conflict.

Ineffective Use of Educational Resources

To examine cost-benefit relationships inherent in present uses of educational resources.

To discover economies of scale, and so on, which might be useful within the present school system; and differentiate between economies which are appropriate for different teaching-learning environments.

Needs of Special Groups

To gear the educational system to handle the special needs of certain segments of the population.

To examine the different roles appropriate to the formal educational system in different circumstances.

CHRONIC PROBLEMS POSSIBLY BECOMING ACUTE

Lack of Diversity of Educational Approaches

To develop diversity within existing forms and structures of the school.

To explore existing obstacles to diversity, such as state laws, standardized testing, etc.

ACUTE PROBLEMS

Equal Educational Opportunity

To define the extent to which formal education is a determinant of life opportunity.

Increasing the Life Opportunities of the Disadvantaged

To critically examine the concept "disadvantaged" and to investigate its characteristics.

Lack of Student Interest, Commitment, Dropouts, Absenteeism

To define the terms "lack of student interest"; "dropout"; absentee"; "lack of commitment" in other than subjective or emotive, non-quantifiable expressions.

To identify and describe those individual and environmental causes of these conditions, including non-school causes and the interaction between personality and environment.

Erosion of Commitment to Scholarly Inquiry

To increase emphasis on critical thinking in college and especially graduate school, aimed not so much at vigorous scientism, but at critical reasoning and the development of conclusions about how to proceed in the face of relative ignorance.

To increase emphasis on the rigorous study of real-world issues of apparent relevance to students.

ADAPTIVE PROBLEMS

Critical Societal Problems and Needs of the Future

To increase the quality of research related to the identification and analysis of critical societal problems and needs of the future.

> *To make educational research and development and educational practice more responsive to future societal problems.*

Flexible Problem-Solving Skills in Real-World Situations

> *To increase the degree to which conventional educational practice can feasibly provide educational experiences which lead to flexible problem-solving skills in the real world, and in environments which are unfamiliar.*
>
> *To identify the principal variables on which effective flexible; or generalizable problem-solving skills are based, and how they can best be imparted to different types of students.*

These goal-statements, like those of Glaser's, although certainly open to dispute and debate, demonstrate the kind of intellectual bridges that must be constructed to span the chasm between present and future. Their great virtue is that—even if they prove eventually to be inappropriate—they will be far from wasted, if only because they deal with problems that already beset us in the here and now.

The ultimate value of the research Glaser suggests we need is that it will profit us to experiment with legitimate pedagogical improvements. The term "alternative"—much abused in the recent literature—has lost meaning because much of what has been proposed lacks originality. The hard fact is that we still know far too little about educational change. Neither bigger, nor more of the same, nor difference for the sake of difference will serve our purpose; instead, we must define the characteristics of the educated person we seek, launch corresponding research and development, measure our results, note our failures, and repeat the process until we find our way to success.

L. R.

RESEARCH AND DEVELOPMENT ISSUES

1. What aspects of the present educational system restrict flexible accommodation to individual requirements and interests?
2. What significant learning abilities are ignored in the present program of instruction?
3. Would it be desirable to work toward alternative educational objectives, or to work toward the same objectives in alternative ways, or both?

4. How can the educational system be reconstituted so as to nurture a wider range of skills and aptitudes?
5. What kinds of teaching activities can be used to increase the child's so-called natural aptitudes and abilities?
6. Can we develop psychometric techniques that, instead of predicting probable success, specify the particular corrective procedures that will insure success?
7. What aspects of cognition would enable us to rely less heavily on purely verbal learning?
8. Should teachers acquire variable methods for accomplishing the same teaching objective in pre-service training, in-service training, or both?
9. How can we best design curricula that take advantage of the child's own cultural inheritance?
10. Can we develop diagnostic devices that permit us to achieve a better personality "fit" between teacher and student?
11. What reorganization will be required to eliminate the arbitrary and indefensible classification of students according to unitary learning abilities?
12. Can special learning exercises increase the child's ability to adapt to schooling?
13. How can a more productive relationship between practice and research be achieved?
14. What revisions should be made in our present sequence of basic research, applied research, development, and application?
15. Would a new kind of alliance between educational researchers and social scientists be desirable?
16. What systemic changes would help to loosen the existing boundaries of grade and time?
17. What are the basic characteristics of an instructional program in which efficient self-directed learning can occur?
18. How should we best proceed to suspend the use of tests that sort children according to preconceived criteria and to develop diagnostic instruments that describe inherent learning style, cognitive and noncognitive development, and the quality of learning performance in natural settings?
19. What kinds of research projects will yield procedures that enable us to extend children's basic aptitudes?

Team Assisted Individualization:
A Cooperative Learning Solution for Adaptive Instruction in Mathematics

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April, 1983

This paper is based on research funded by grands from the National Institute of Education (No. NIE-G-83-0002) and by the Office of Special Education, U.S. Department of Education (No. G008001494). However, the opinions expressed are mine, and do not represent official policy.

The research reported here was done in collaboration with Marshall Leavey, Nancy Madden, Sabine Oishi, and Reva Bryant.

The issue of whether and how to adapt instruction to individual differences in student ability or achievement has been one of the most long-standing controversies in American education. At various times, opinions and practices have alternatively favored such practices as tracking, within-class ability grouping, programmed instruction, computer-assisted instruction, and mastery learning as means of attempting to insure that the needs and readiness of every student are taken into account in instruction. The need for some sort of individualization has been perceived as particularly great in mathematics, where learning of each skill depends in large part on mastery of prerequisite skills.

The rationale behind individualization of mathematics instruction is that students enter class with widely divergent knowledge, skills, and motivation. When the teacher presents a single lesson to a diverse group, it is likely that some students will not have the prerequisite skills to learn the lesson, and will fail to profit from it. Others will already know the material, or will learn it so quickly that additional time spent going over the lesson will be wasted for them. Karweit (1983) and Slavin (in press) have hypothesized that small, inconsistent effects of time on-task on achievement (net of ability) are due at least in part to a lack of correspondence in group-paced instruction between what is taught and students' levels of readiness and individual learning rates.

It is clear that teaching a single lesson at a single pace to a heterogeneous class incurs certain inefficiencies in the use of instructional time. In theory, maximum instructional efficiency should be achieved when material presented to students is exactly appropriate to their levels of readiness and procedes at as rapid a pace as students can assimilate information. The substantial effects of one-to-one tutoring on student achievement (see, for example, Glass, Cahen, Smith, and Filby, 1981) probably arise in part from the ability of the adult tutor to establish a level and pace of instruction that is closely tailored to the needs of the individual student being tutored.

However, students overwhelmingly learn in class groups, not in individual tutoring sessions. Individualizing instruction in class groups entails costs in instructional efficiency that may equal or exceed the inefficiencies introduced by the use of a single level and pace of instruction. For example, programmed instruction provides complete individualization of instruction, allowing students to procede at their own rates on materials appropriate to their level of prior knowledge. Yet programmed instruction inevitably reduces the amount of time teachers can spend in direct instructional activities and increases the amount of time students spend doing seatwork. In studies of group-paced instruction, time spent on seatwork has typically been negatively associated with learning, while time spent on direct instruction has had positive effects on learning (see Brophy, 1979; Good, 1979). Time spent checking materials and managing the program is largely time lost from instruction. Motivation is often lacking in programmed instruction, as students may place little value on progress for its own sake, and may become bored with endless interaction with written materials alone (see Kepler and Randall, 1977, and Schoen, 1976, for discussions of the problems of programmed instruction).

Reviews of research on programmed instruction in mathematics (e.g., Miller, 1976; Schoen, 1976) uniformly conclude that programmed instruction is no more effective than traditional methods in increasing student achievement. Given the costs and difficulties of implementing programmed instruction, one might argue that this approach should be abandoned as unworkable and ineffective.

Yet the problems of student heterogeneity programmed instruction was designed to address will not go away. If anything, classes are becoming more, not less heterogeneous as a consequence of such movements as mainstreaming, desegregation (which sometimes brings about abandonment of tracking), and shrinking school sizes (which restricts possibilities for tracking). Tracking itself is increasingly being questioned as an effective means of dealing with the problem of student heterogeneity. Studies of tracking find few achievement benefits for this practice (see Esposito, 1973; Good & Marshall, in press; Kulik & Kulik, 1982), except perhaps for gifted students (but see Slavin, 1983b for criticism of this research).

Rather than abandon programmed instruction, we began a project at the Johns Hopkins Center for Social Organization of Schools to attempt to resolve as many of the problems of programmed instruction as possible. We hoped to reap the achievement benefits of providing instruction appropriate to the needs and skills of individual students by reducing the time and management costs of programmed instruction and increasing the amount of direct instruction teachers could deliver in coordination with the individualized program. Our plan was to have the students themselves handle the routine management and checking required for the individualized program in small, heterogeneous teams, and to reward the teams based on the number and accuracy of units completed by all team members. In a decade of research on group-paced cooperative learning methods (see Slavin, 1980, 1983a), we had found that team incentives were effective in motivating students to help and encourage one another to achieve, and thus were consistently effective in increasing student achievement. We now wished to apply the same principle to motivate students to help and encourage one another to do individualized units quickly and accurately.

By having student teams take responsibility for routine management and checking, for helping one another with problems, and for encouraging one another to achieve, we felt it would be possible to free the teacher to provide direct instruction to small, homogeneous groups of students drawn from the heterogeneous teams. We intended this instruction to focus on the concepts behind the algorithms students were learning in their individualized work, and we thus hoped to integrate the teacher's instruction to the homogeneous teaching groups with the individualized work.

In addition to solving the problems of management and motivation in programmed instruction, we hoped to create a method that would take advantage of the considerable socialization potential of cooperative learning. Previous studies of group-paced cooperative learning methods have consistently found positive effects of these methods on such outcomes as race relations and attitudes toward mainstreamed, academically handicapped students (see Slavin, 1980, 1983a). We thus had good reason to expect that similar outcomes could be achieved in a method combining cooperative learning and individualized instruction.

Team Assisted Individualization

To solve the theoretical and practical problems of programmed instruction, we set out to create a method that would satisfy the following criteria:

--The teacher would be minimally involved in routine management and checking.

--The teacher would spend at least half of his or her time teaching small groups.

--Program operation would be so simple that students of any age could manage it.

--Students would be motivated to procede rapidly and accurately through the materials, and could not do so by cheating or finding shortcuts.

--Many mastery checks would be provided so that students would rarely waste time on material they had already mastered or run into serious difficulties requiring teacher help. At each mastery checkpoint, alternative instructional activities and parallel tests would be provided.

--Students would be able to check one anothers' work, even when the checking student was behind the student being checked, and the checking procedure would be simple and not disruptive to the checker.

--The program would be simple to learn for teachers and students, inexpensive, and flexible, and would not require aides or team teachers.

--The program would, by having students work in cooperative, equal-status groups, establish conditions for positive attitudes toward mainstreamed, academically handicapped students and between students of different racial or ethnic background.

The TAI program that was developed to meet the above criteria was first pilotted in a single class, extensively revised, studied in two full-scale but brief (8 and 10 weeks, respectively) field experiments, revised again, and studied in a 24-week field experiment . The TAI program as applied in the field experiments consisted of the following components.

1. Teams. Students were assigned to four- to five-member teams by the project staff. Each team consisted of a mix of high, average, and low achievers as determined by a placement test, boys and girls, and students of any ethnic groups in the class represented in the proportion they made up of the entire class. Students identified as receiving resource help for a learning problem were evenly distributed among the teams. Every eight weeks, students were reassigned to new teams by their teachers according to the same procedures.

2. Placement test. The students were pretested at the beginning of the project on mathematics operations. Students were placed at the appropriate point in the individualized program based on their performance on the diagnostic test.

3. Curriculum materials. During the individualized portion of the TAI process, students worked on prepared curriculum materials covering addition, subtraction, multiplication, division, numeration, decimals, fractions, word problems, and introduction to algebra. These materials had the following subparts:

--An Instruction Sheet explaining the skill to be mastered and giving a step-by-step method of solving problems.

--Several Skillsheets, each consisting of twenty problems. Each skillsheet introduced a subskill that led to final mastery of the entire skill.

--A Checkout, which consisted of two parallel sets of ten items.

--A Final Test.

--Answer Sheets for Skillsheets, Checkouts, and Final Tests.

4. Team Study Method. Following the placement test, students were given a starting point in the individualized mathematics units. They worked

on their units in their teams, following these steps:

--Students formed into pairs or triads within their teams. Students located the unit they were working on and brought it to the team area. Each unit consisted of the Instruction Sheet, Skillsheets, and Checkout stapled together, and the Skillsheet Answer Sheets and Checkout Answer Sheets stapled together.

--Students exchanged Answer Sheets with partners within their teams.

--Each student read his or her Instruction Sheet, asking teammates or the teacher for help if necessary, and then began with the first Skillsheet in his or her unit.

--Each student worked the first four problems on his or her own Skillsheet and then had his or her partner check the answers against the Answer Sheet. If all four were correct, the student could immediately go on to the next Skillsheet. If any were wrong, the student had to try the next four problems, and so on until he or she got one block of four problems correct (asking teammates or the teacher for help if needed).

--When a student got four in a row on the last Skillsheet, he or she could take Checkout A, a ten-item quiz that resembled the last Skillsheet. On the Checkout, students worked alone until they were finished. When they were finished, a teammate scored the Checkout. If the student got eight or more items correct, the teammate signed the Checkout to indicate that the student was certified by the team to take the Final Test. If the student did not get eight correct, the teacher was called in to explain any problems the student was having. The teacher would then ask the student to work again on certain Skillsheet items. The student then took Checkout B, a second ten-item test comparable in content and difficulty to Checkout A. Otherwise, students skipped Checkout B and went straight to the Final Test. No student would take the Final Test until he or she had been passed by a teammate on a Checkout. When a student "checked out," he or she took the Checkout to a student monitor from a different team to get the appropriate Final Test. The student then completed the Final Test, and the monitor scored it. Two or three students served as monitors each day, rotating responsibility among the class every day.

5. Team Scores and Team Recognition. At the end of each week, the teacher computed a team score. This score was based on the average number of units covered by each team member, with extra points for perfect or near-perfect papers. Criteria were established for team performance. A high criterion was set for a team to be a "SUPERTEAM," a moderate criterion was established for a team to be a "GREATTEAM," and a minimum criterion was set for a team to be a "GOODTEAM." The teams meeting the "SUPERTEAM" and "GREATTEAM" criteria received attractive certificates.

6. Teaching Groups. Every day, the teacher worked with groups of students who were at about the same point in the curriculum for 5-15 minute sessions. The purpose of these sessions was to prepare students for major concepts in upcoming units and to go over any points with which students were having trouble. Teachers were instructed to emphasize concepts rather than algorithms in their instruction, as the individualized materials were considered adequate for teaching algorithms but not concepts.

Research on TAI

Three field experiments have been conducted to evaluate the effects of TAI on student achievement, attitudes, and behavior. The methods and

and results of these studies are described in the following sections.

Experiment 1

Experiment 1 (Slavin, Leavey, & Madden, in press; Slavin, Madden, & Leavey, 1982) was the first full-scale evaluation of TAI.

Experiment 1: Methods

Subjects and Design. The subjects in Experiment 1 were 504 students in grades 3, 4, and 5 in a middle-class suburban Maryland school district. Eighty percent of the students were white, 15% were black, and 5% were Asian (primarily Korean). Six percent of the students were receiving special education services for a serious learning problem at least one hour per day, and an additional 17% of the students were receiving other educational services, such as special reading or speech instruction. The students were in eighteen classes in six schools. The schools were randomly assigned to one of three conditions: Team Assisted Individualization (TAI), Individualized Instruction (II) without student teams, or Control. These treatments are described below. One third, fourth, and fifth grade class was then selected to participate in the study in each school. The three treatments were implemented for eight weeks in Spring, 1981.

Treatments

1. Team-Assisted Individualization (TAI). TAI was implemented as described above.

2. Individualized Instruction (II). The II group used the same curriculum materials and procedures as the TAI group with the following exceptions:

--Students worked individually, not in teams. They checked their own answer sheets for all Skillsheets and Checkouts. Criteria for going on (i.e., four correct for Skillsheets and eight out of ten for Checkouts) were the same as for TAI).

--Students did not receive team scores or certificates.

In all other respects, including curriculum organization, student monitors, teacher review sessions, and recordkeeping, the II treatment was identical to TAI.

3. Control. The control group used traditional methods for teaching mathematics, which consisted in every case of traditional texts and group-paced instruction, supplemented by small homogeneous teacher-directed math groups.

Measures

1. Mathematics Achievement. The Mathematics Computation subscale of the Comprehensive Test of Basic Skills (CTBS), Level 2, Form 2, was administered as a pre- and posttest of student mathematics achievement. The CTBS (rather than a curriculum-specific test) was used to be sure experimental and control classes would have equal opportunities to have their learning be registered on the test. No efforts were made to design the curriculum materials to correspond to the CTBS items.

2. Attitudes. Two eight-item attitude scales were given as pre- and posttests. The scales were Liking of Math Class (e.g., "This math class is the best part of my school day"), and Self-Concept in Math (e.g., "I'm proud of my math work in this class;" "I worry a lot when I have to take a math test"). For each item, students marked either YES!, yes, no, or NO!. Scores of negatively scored items were reversed, so that high scale scores indicated more positive attitudes.

3. Behavior Ratings. Teachers rated a sample of their students at pre- and posttesting on the School Social Behavior Rating Scale, or SSBRS. The subsamples consisted of all students receiving some form of special service for a learning problem (e.g., reading or math resource, speech, or

special education), plus a random selection of six other students. The SSBRS consists of four scales designed to elicit teacher ratings of student behavioral and interpersonal problems. Students receiving special services were oversampled because they were seen as most likely to have behavioral and interpersonal problems that might be remedied by a cooperative-individualized treatment (see Slavin, Madden, and Leavey, 1982). The four scales were Classroom Behavior (e.g., "Does not attend to work)), Self-Confidence (e.g., "Becomes easily upset by failures"). Friendships (e.g., "Has few or no friends"), and Negative Peer Behavior (e.g., "Fights with other students"). There were six items in the Negative Peer Behavior Scale, and eight in the other three scales. A factor analysis using varimax rotation produced factor loadings consistent with a priori scales.

4. Peer Rating. A peer rating form was given at pre- and posttesting to assess acceptance and rejection of mainstreamed students. Each student was given a class list and was asked to mark each classmate as "a best friend" or "okay." Two measures were derived from this. The first was the number of nominations as "best friend" received by mainstreamed students. The second was the number of times mainstreamed students were listed neither as "best friends" nor as "okay," taken to be an indication of rejection. Only within-sex choices for boys were analyzed, as there were very few mainstreamed girls in the sample.

Experiment 1: Results

The data were analyzed by means of multiple regressions, where for each dependent variable (posttest), the R^2 for a full model including pretest, grade, and treatment was tested against the R^2 for pretest and grade.

Insert Tables 1 & 2 Here

The pre- and posttest means on all dependent variables taken on the full sample by treatment are shown in Table 1. Table 2 presents the results of the multiple regressions, including both the overall (3 x 1) results and each of the pairwise comparisons.

The results for the Comprehensive Test of Basic Skills (CTBS) indicated a marginally significant ($p < .07$) overall treatment effect, controlling for pretest and grade. The TAI group gained significantly more in achievement than the Control group, while the II group gained marginally ($p < .09$) more than the Control group. However, there were no significant differences between the TAI and II groups.

Results for the Liking of Math scale indicated a signficant overall treatment effect, as well as significant differences between TAI and Control and between II and Control, with both experimental groups scoring higher than the control group, controlling for pretest and grade. There were no differences between TAI and II. Overall treatment effects were also found for Self-Concept in Math. TAI significantly exceeded Control on this variable while II marginally ($p < .08$) exceeded the Control group.

Statistically significant overall treatment effects beyond the .001 level were found for all four behavioral rating scales (see Tables 1 and 2). For Class Behavior, TAI students were rated as having significantly fewer problems, controlling for pretest and grade, than either Control students or II students, but there were no differences between II and Control. On Self-Confidence, the Control group was rated as having more problems than either TAI students or II students. The TAI group had fewer problems reported than the II group. The Control classes were also scored as having more friendship problems than either TAI classes or II classes, but there were no differences between TAI and II. The same pattern of effects was seen for ratings of Negative Peer Behavior--more problems were reported in the Control classes than in the TAI or II classes, but there were no differences between TAI and II.

Insert Tables 3 & 4 Here

Tables 3 and 4 summarize the results of analyses for the mainstreamed subsample (from Slavin, Madden, & Leavey, 1982). Analyses of covariance indicate that TAI students exceeded control students on both sociometric measures (i.e., they gained more "best friends" nominations and were less often rejected). TAI students were also reported to have fewer problems than control students on all four behavior rating scales, and were higher in liking of math class. Interestingly, the same pattern of results was found for the comparison of II and Control treatments, with the exception of the Classroom Behavior scale, on which there were no differences. TAI students exceded II students only on the Classroom Behavior and Self-Confidence ratings, and on the Self-Concept in Math questionnaire scale.

Experiment 2

Experiment 2 was conducted primarily as a replication of the TAI-Control comparison studied in Experiment 1.

Experiment 2: Methods

Subjects and Design. The subjects in Experiment 2 were 375 students in grades 4, 5, and 6 in another suburban Maryland school district. Fifty-five percent of the students were white, 43% were black, and 2% were Asian. Four percent of the students were receiving special education services for a serious learning problem at least one hour per day, and an additional 23% of the students were receiving other special educational services, such as special reading or speech instruction. Four schools were involved in the study: two TAI schools were matched with two Control schools.

One TAI and one Control school were primarily middle- to lower-class in student population; one TAI and one Control school were primarily lower class. A total of ten TAI and six Control classes participated in the study.

Treatments. Experiment 2 compared TAI to Control methods (as described for Experiment 1) for ten weeks in Spring, 1981.

Measures. The achievement, attitude, and behavioral rating measures were the same as in Experiment 1.

Experiment 2: Results

The data were analyzed exactly as in Experiment 1, using multiple regressions testing the R^2 for a full model including treatment to that for a restricted model including only pretest and grade.

Insert Tables 5 & 6 Here

The pre- and posttest means by treatment are shown in Table 5, and the results of the multiple regressions are summarized in Table 6.

The results for the CTBS closely mirror the TAI vs. Control comparison in Experiment 1. The TAI students scored significantly higher than Control students, controlling for pretest and grade. However, there were no significant differences on the Liking of Math Class or Self-Concept in Math scales. Controlling for pretests and grade, the TAI teachers reported significantly fewer problems than the Control teachers with regard to Self-Confidence and Friendships, but there were no differences seen on Classroom Behavior or Negative Peer Behavior.

Thus, while the achievement results of Experiment 2 confirm the TAI vs. Control comparison in Experiment 1, the strong attitude effects were not replicated, and the behavioral rating results of Experiment 1 were replicated only for Self-Confidence and Friendship Behaviors.

Experiment 3

Experiment 3 was conducted to assess the achievement effects of TAI over a longer period than in Experiments 1 and 2, to rule out the possibility that the positive effects found in the earlier experiments were due to short-lasting Hawthorne effects, to establish the usefulness of TAI as the primary means of delivering mathematics instruction, and to study the effects of TAI on the Mathematics Concepts and Applications scale of the CTBS as well as on the Mathematics Computations scale used in the earlier studies.

Experiment 3: Methods

Subjects and Design. The subjects in Experiment 3 were 1317 students in grades 3, 4, and 5 in the same middle-class suburban school district that participated in Experiment 1. Seven hundred students in 31 classes in four schools were assigned to use TAI, and 617 students in 30 classes in three similar schools matched on grade-level, district-administered California Achievement Test scores and type of neighborhood, served as the control group. The treatments were administered over a 24-week period from December, 1981, to May, 1982.

Measures. The only measures used were the Math Computations and Math Concepts and Applications scales of the CTBS. Students in grades 3-4 took Level 2, Form S of the CTBS, while those in grade 5 took Level H, Form U. Scores from corresponding scales of the California Achievement Test (CAT), given by the district in the fall of the third and fifth grades, served as covariates to adjust for any initial differences in achievement level (none were statistically significant) and to increase statistical power. Thus, for third and fifth graders the CAT scores were recent, but for fourth graders, fall third grade scores had to be used.

Experiment 3: Results

The data were analyzed by means of analyses of covariance. For analyses involving the CTBS Mathematics Computations Scale, CAT Mathematics Computations scores were used as the covariate; for CTBS Concepts and Applications, the corresponding CAT scores were used as the covariate. Analyses were conducted separately for each grade level. Also, an overall analysis was conducted by changing all scores to z-scores, adjusting posttest scores for covariates, and then conducting an analysis of variance on the residualized scores.

Table 7 About Here

The results are summarized in Table 7. While all analyses were conducted using raw scores, Table 7 presents grade equivalents for ease of interpretation of the different tests.

TAI classes gained more than control classes (controlling for CAT scores) on every test at every grade level, but the differences reached statistical significance for Mathematics Computations at grades 3 and 5 but not 4. There were significant differences at grade 4 and marginal ($p<.09$) differences at grade 5 for Mathematics Concepts and Applications. In the overall analyses, the TAI classes significantly exceded control classes on both tests ($p<.001$).

Discussion

The results of the three field experiments evaluating Team-Assisted Individualization (TAI) clearly indicate that this method that this method increases students' mathematics achievement more than traditional instructional methods. On every achievement measure in every study, the TAI students gained more than their control counterparts, although the differences were not statistically significant on some subscales at some grade levels in Experiment 3. Experiment 3 demonstrated that TAI could be used over an extended time period (most of a school year) as the primary means of delivering mathematics instruction.

In operation, TAI was found to satisfy most of the criteria outlined earlier in this paper. In all three studies, students were able to take on routine maintenance and checking functions. In fact, students' abilities to responsibly carry out the various program activities, including checking partners, routing themselves, recording scores, and serving as monitors exceeded our initial expectations. The team reward system did seem to be very motivating, and students greatly enjoyed both the program itself and making progress in it. Several teachers reported difficulty getting students to go to the next class; many students asked to do math all day!

One criterion that was only partially met was that teachers would be able to spend at least half of their time teaching small groups. In the three experiments reported here, most teachers worked with individuals rather than small groups most of the time. We felt that this provided students with inadequate direct instructional time.

In current applications of TAI, we have changed the procedure to make teaching groups easier to manage and have emphasized teaching groups more in teacher training. Most teachers who use TAI now do spend at least half of their class time teaching small groups of students. The effects of this will not be known until the results of the current year's studies are analyzed.

Teachers have responded very favorably to TAI, and approximately 80% of all teachers who used TAI in the experimental studies continued to do so in the following school year.

One important theoretical issue is posed by the results of Experiment 1. In that study, the use of the indivudalized materials and all procedures except the cooperative teams increased student achievement (as compared to control students) almost as much as the full TAI program. Besides the materials themselves, this individualized instruction (II) treatment retained the student-managed aspect of TAI, including student monitors and self-routing, freeing the teacher to work with individuals and small groups, as in TAI. This result suggests that the cooperative teams may not be essential to TAI, but that the positive achievement effects seen for TAI are due either to student management of an individualized program or to the particular individualized materials themselves. However, Experiment 1 lasted only eight weeks; it is possible that over a longer period, the cooperative incentives and peer interaction would be needed to maintain student interest and motivation. A longer study comparing TAI with and without cooperative incentives is currently being planned.

The results of Experiment 1 for the mainstreamed subsample indicate that TAI can have a strong positive effect on the social acceptance and behavior of academically handicapped students. The sociometric findings mirror effects of group-paced cooperative learning methods (see Madden & Slavin, 1982). The behavioral rating effects are particularly dramatic. All academically handicapped students were rated as much worse in behavior than their non-handicapped classmates at the beginning of the study. By the end, ratings of academically handicapped students in the TAI classes were nearly identical to ratings of non-handicapped students in the control classes!

However, it is important to note that on most of the sociometric and behavioral rating measures, the II group performed almost as well as the TAI group. This was even more surprising than the parallel finding for achievement. Meece and Wang (1982) also found positive effects of an individualized program without cooperative groups on acceptance of academically handicapped students. Slavin, Madden, and Leavey (1982) and Madded and Slavin (1982) discuss these findings at some length, suggesting that we may have underestimated the social benefits of individualized instruction. The II condition did not contain the cooperative work groups hypothesized to be the principle factor explaining the success of cooperative learning methods in improving relationships among diverse students (see Slavin & Hansell, in press). However, it does have other features that should have similar effects, particularly as regards acceptance of academically handicapped students. First, it removes (or certainly reduces) individual competition between students. Non-competition has been found to reduce the degree to which students form a "pecking order" based on perceived intelligence, characteristic of the traditional competitive class (see Ames, Ames, & Felker, 1977). Second, in the context of individualized instruction, it may be difficult or impossible to pick out the academically handicapped students. They are engaging in activities similar to those of their classmates, and are likely to experience success, as they are working on materials appropriate to their needs. This may make it possible for mainstreamed students to behaviorally blend in with their non-handicapped classmates to a degree that would be unusual in a traditional classroom, where these students must either be set apart to receive different stigmatizing tasks, or must often experience public failure (see Madden & Slavin, 1982). Finally, students are allowed to interact in individualized instruction, and this amount of interaction may be enough to create the positive social effects characteristic of cooperative learning methods.

Two recent studies (Oishi, Slavin, & Madden, 1983; Oishi, 1983) have investigated the effects of TAI on race relations. Both studies found that TAI improved attitudes and friendships among black and white students in Baltimore classrooms. Interestingly, the effects were stronger for decreasing negative attitudes than for increasing positive ones (though both outcomes were found). However, our experience implementing TAI in Baltimore elementary schools makes us cautious in recommending this method for use in low-achieving urban settings. In most of the classes involved in these studies, neither students nor teachers appeared to be able to handle the increased responsibility and autonomy given to students in TAI. High concentrations of students with serious reading problems and behavior problems made the program very difficult to implement. Preliminary analyses of achievement data from these studies indicate that TAI students learned no more (or less) than control students. On the other hand, research currently underway in inner-city Wilmington, Delaware schools indicates that TAI can be implemented well in urban settings. Wilmington has an extensive metropolitan desegregation plan that mixes students of quite diverse social class backgrounds in every class, avoiding the concentrations of low achievers seen in many of the Baltimore City classes. Work directed at making TAI more effective in low-achieving inner-city schools will continue.

Research on TAI is currently at an intermediate stage. The basic achievement effects of the program have been demonstrated in three field experiments, and a number of positive social and attitudinal effects have been found. Research and development are continuing to improve the program (and hopefully improve program outcomes further), to explore effects other than achievement, and to resolve remaining theoretical and practical issues raised by the earlier experiments. However, at this point we can tentatively conclude that we were correct in our initial assumption: if the problems of management, motivation, and direct teaching characteristic of previous programmed instruction could be solved, the benefits of providing instruction appropriate to students needs can finally be realized.

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Table 1

Means and Standard Deviations of
Achievement, Attitude, and Behavioral Rating
Variables by Treatment, Experiment 1

		TAI		II		Control	
		X	(S.D.)	X	(S.D.)	X	(S.D.)
CTBS Achievement	Pre	30.18	(10.08)	28.51	(11.59)	29.25	(11.[illegible]
	Post	33.12	(9.43)	31.45	(11.31)	31.02	(11.86)
	N	138		148		148	
Liking of Math Class	Pre	24.37	(6.23)	25.02	(5.09)	23.23	(5.07)
	Post	25.09	(6.19)	25.51	(4.35)	21.93	(5.75)
	N	147		150		154	
Self-Concept in Math	Pre	24.87	(4.13)	24.23	(4.89)	24.56	(4.16)
	Post	25.80	(4.23)	24.97	(4.42)	24.40	(4.72)
	N	145		150		153	
Behavior Rating* Classroom Behavior	Pre	5.07	(4.85)	4.35	(5.37)	4.81	(5.88)
	Post	2.93	(3.43)	5.26	(7.85)	5.41	(5.85)
	N	58		68		83	
Behavior Rating* Self-Confidence	Pre	3.97	(3.76)	4.12	(5.32)	2.64	(3.55)
	Post	1.90	(2.80)	3.31	(5.05)	3.78	(4.57)
	N	58		67		83	
Behavior Rating* Friendships	Pre	1.95	(3.29)	4.46	(7.19)	2.00	(3.32)
	Post	1.57	(3.89)	2.79	(5.48)	3.17	(4.08)
	N	58		67		83	
Behavior Rating* Negative Peer Behavior	Pre	2.00	(3.13)	2.13	(4.08)	1.82	(3.00)
	Post	0.94	(1.94)	1.16	(2.58)	2.87	(3.76)
	N	49		67		83	

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*For the behavioral ratings, high scores indicate more problems reported.

From Slavin, Leavey, & Madden, in press

Table 2

Results of Multiple Regressions, Experiment 1

	R^2 Total	R^2 Inc	F	d.f.	$p <$
CTBS					
Overall	.752	.003	2.76	2,431	.07
TAI vs Control	.769	.004	5.39	1,284	.03
TAI vs II	.721	.000	<1	1,284	n.s.
II vs Control	.766	.002	2.90	1.294	.09
Liking of Math Class					
Overall	.327	.035	11.66	2,448	.001
TAI vs Control	.360	.035	16.37	1,299	.001
TAI vs II	.275	.000	<1	1,295	n.s.
II vs Control	.312	.004	19.50	1,302	.001
Self-Concept in Math					
Overall	.410	.011	4.13	2,445	.01
TAI vs Control	.442	.014	7.28	1,296	.01
TAI vs II	.382	.003	1.28	1,293	n.s.
II vs Control	.406	.006	3.21	1,301	.08
Behavior Rating: Classroom Behavior					
Overall	.600	.041	10.43	2,204	.001
TAI vs Control	.672	.066	27.55	1,137	.001
TAI vs II	.471	.049	11.25	1,122	.001
II vs Control	.609	.000	<1	1,147	n.s.
Behavior Rating: Self-Confidence					
Overall	.536	.071	15.52	2,203	.001
TAI vs Control	.577	.118	38.25	1,137	.001
TAI vs II	.478	.024	5.51	1,121	.03
II vs Control	.571	.032	10.88	1,146	.001
Behavior Rating: Friendships					
Overall	.549	.040	9.10	2,203	.001
TAI vs Control	.595	.036	12.15	1.137	.001
TAI vs II	.541	.001	<1	1,121	n.s.
II vs Control	.549	.044	14.24	1,146	.001
Behavior Rating: Negative Peer Behavior					
Overall	.507	.075	20.80	2,194	.001
TAI vs Control	.526	.105	28.30	1,128	.001
TAI vs II	.405	.002	<1	1,112	n.s.
II vs Control	.561	.088	29.24	1,146	.001

From Slavin, Leavey, & Madden, in press.

Table 3

Means and Standard Deviations of Sociometric, Behavior Rating, Achievement, and Attitude Variables by Treatment, Mainstreamed Subsample, Experiment 1

		TAI		MO		Control	
		X	S.D.	X	S.D.	X	S.D.
"Best Friends"	Pre	5.86	3.21	4.34	3.68	4.54	2.84
	Post	6.04	3.02	4.61	3.66	4.00	2.08
	N	22		18		23	
"Rejections"	Pre	2.85	2.37	4.52	2.88	4.22	2.92
	Post	2.49	2.43	3.60	2.72	4.77	2.65
	N	22		18		23	
Behavior Rating: Classroom Behavior	Pre	7.48	5.47	6.06	7.20	7.33	6.85
	Post	3.84	2.70	8.29	9.77	8.35	6.42
	N	25		34		40	
Behavior Rating: Self-Confidence	Pre	6.00	4.14	7.07	6.51	3.77	4.26
	Post	2.84	3.20	6.17	6.40	5.10	5.18
	N	25		29		40	
Behavior Rating: Friendships	Pre	2.88	3.89	5.71	7.90	2.70	3.67
	Post	1.80	3.91	3.26	4.66	4.20	4.18
	N	25		34		40	
Behavior Rating: Negative Peer Behavior	Pre	2.88	3.46	3.00	5.20	2.70	3.65
	Post	1.17	2.60	1.62	3.11	4.15	4.20
	N	18		34		40	
CTBS	Pre	27.6	12.1	22.8	10.3	24.9	11.5
	Post	27.2	12.3	25.3	11.6	25.4	13.0
	N	22		36		40	
Liking of Math Class	Pre	14.2	5.25	14.4	5.17	16.3	4.34
	Post	14.4	5.69	14.9	6.05	18.1	5.52
	N	27		37		39	
Self-Concept in Math	Pre	16.1	4.57	15.8	5.44	16.6	3.54
	Post	14.7	4.78	16.5	5.29	15.8	3.38
	N	27		37		39	

From Slavin, Madden, & Leavey, 1982.

Table 4

Results of Analyses of Covariance, Mainstreamed Subsample, Experiment 1

	F	d.f.	p <	Direction
"Best Friends"				
Overall	2.98	2,58	.06	
TAI vs. Control	5.91	1,41	.02	TAI > C
TAI vs. MO	<1	1,36	n.s.	
MO vs. Control	4.81	1,37	.04	MO > C
"Rejections"				
Overall	4.55	2,58	02	
TAI vs. Control	6.36	1,41	02	TAI > C
TAI vs. MO	1	1.36	n.s.	
MO vs. Control	5.32	1,37	.03	MO > C
Behavior Ratings: Classroom Behavior				
Overall	8.87	2,94	.01	
TAI vs. Control	28.10	1,61	.001	TAI > C
TAI vs. MO	10.37	1,55	.002	TAI > C
MO vs. Control	<1	1,70	n.s.	
Behavior Ratings: Self-Confidence				
Overall	8.56	2,89	.001	
TAI vs. Control	31.87	1,61	.001	TAI > C
TAI vs. MO	5.65	1,50	.03	TAI > MO
MO vs. Control	3.09	1,65	.09	MO > C
Behavior Ratings: Friendships				
Overall	7.97	2,94	.001	
TAI vs. Control	14.82	1,61	.001	TAI > C
TAI vs. MO	<1	1,55	n.s.	
MO vs. Control	12.66	1,70	.001	MO > C
Behavior Ratings: Negative Peer Behavior				
Overall	17.09	2,87	.001	
TAI vs. Control	22.15	1,54	.001	TAI > C
TAI vs. MO	<1	1, 48	n.s.	
MO vs. Control	32.70	1,70	.001	MO > C
CTBS				
Overall	1.44	2,93	n.s.	
TAI vs. Control	<1	1,58	n.s.	
TAI vs. MO	2.24	1,54	n.s.	
MO vs. Control	1.54	1,72	n.s	
Liking of Math Class				
Overall	2.66	2,98	.08	
TAI vs. Control	3.69	1,62	.06	TAI > C
TAI vs. MO	<1	1,60	n.s.	
MO vs. Control	3.40	1,72	.07	MO > C
Self-Concept in Math				
Overall	2.45	2,98	.10	
TAI vs. Control	1,10	1,62	n.s.	
TAI vs. MO	3.67	1,60	.06	TAI > MO
MO vs. Control	1.79	1,72	n.s.	

From Slavin, Madden, & Leavey, 1982.

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Table 5

Means and Standard Deviations of Achievement, Attitude, and Behavioral Rating Variables by Treatment, Experiment 2

		TAI		Control	
		X	(S.D.)	X	(S.D.)
CTBS Achievement	Pre	28.50	(9.39)	27.12	(9.87)
	Post	30.84	(9.16)	28.40	(9.36)
	N	189		114	
Liking of Math Class	Pre	22.34	(5.98)	23.97	(5.97)
	Post	23.07	(6.28)	23.96	(6.03)
	N	192		113	
Self-Concept in Math	Pre	22.35	(4.61)	23.61	(4.75)
	Post	24.36	(4.82)	23.95	(4.69)
	N	192		113	
Behavior Rating*: Classroom Behavior	Pre	8.62	(9.09)	8.64	(6.03)
	Post	8.97	(9.55)	8.00	(7.52)
	N	107		74	
Behavior Rating*: Self-Confidence	Pre	3.88	(4.22)	4.67	(4.63)
	Post	3.66	(3.70)	5.25	(5.22)
	N	82		73	
Behavior Rating*: Friendships	Pre	2.32	(3.96)	3.23	(4.56)
	Post	1.81	(3.44)	3.92	(5.47)
	N	81		64	
Behavior Rating*: Negative Peer	Pre	3.83	(5.71)	3.92	(4.43)
	Post	3.64	(5.87)	4.60	(5.35)
	N	107		73	

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*For the behavioral ratings, high scores indicate more problems reported.

From Slavin, Leavey, & Madden, in press.

Table 6

Results of Multiple Regressions, Experiment 2

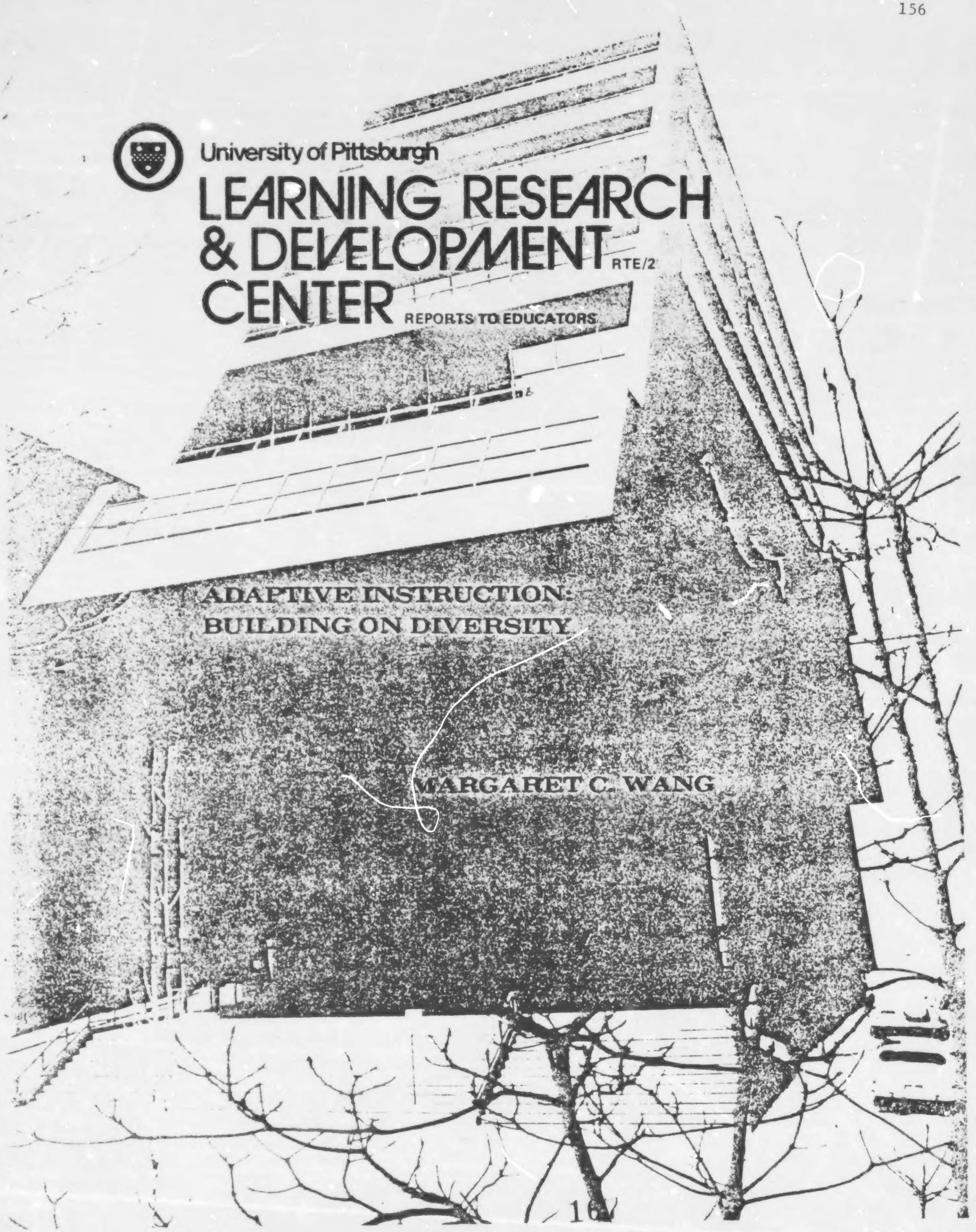
	R^2_{Total}	R^2_{Inc}	F	d.f.	$p <$
CTBS	.602	.006	4.70	1,299	.03
Liking of Math Class	.307	.000	<1	1,301	n.s.
Self-Concept in Math	.376	.004	1.86	1,301	n.s.
Behavioral Rating: Classroom Behavior	.633	.004	1.92	1,177	n.s.
Behavioral Rating: Self-Confidence	.567	.018	6.27	1,151	.02
Behavioral Rating: Friendships	.545	.023	7.07	1,141	.01
Behavioral Rating: Negative Peer Behavior	.608	.006	2.67	1,176	n.s.

From Slavin, Leavey, & Madden, in press.

Table 7
Mean CTBS Scores in Grade Equivalents and Results on Analyses of Covariance, Experiment 3

	TAI	Control	F	p <
Grade 3-Comp.				
Pre (Gr. 3 CAT)	3.85	3.69		
Post (CTBS II)	4.88	4.61	5.81	.02
N	246	204		
Grade 3-C & A				
Pre	4.48	4.35		
Post	5.35	5.06	1.86	NS
N	245	206		
Grade 4-Comp				
Pre (Gr. 3CAT)	3.71	3.39		
Post (CTBS II)	5.71	5.37	<1	NS
N	219	162		
Grade 4-C & A				
Pre	4.16	4.00		
Post	6.63	5.97	10.80	.001
N	217	164		
Grade 5-Comp.				
Pre (Gr. 3 CAT)	6.15	6.26		
Post (CTBS H)	7.49	7.27	19.61	.001
N	239	247		
Grade 5-C & A				
Pre	6.88	6.68		
Post	8.02	7.65	2.86	.09
N	238	247		
Overall-Comp				
Pre	4.59	4.65		
Post	6.02	5.88	13.12	.001
N	704	613		
Overall-C & A				
Pre	5.20	5.19		
Post	6.49	6.34	13.61	.001
N	700	617		

From Slavin, Leavey, & Madden, 1983.



University of Pittsburgh

LEARNING RESEARCH & DEVELOPMENT CENTER

RTE/2

REPORTS TO EDUCATORS

ADAPTIVE INSTRUCTION: BUILDING ON DIVERSITY

MARGARET C. WANG

The research reported herein was supported by the Learning Research and Development Center, supported in part as a research and development center by funds from the National Institute of Education (NIE), United States Department of Health, Education, and Welfare. The opinions expressed do not necessarily reflect the position or policy of NIE, and no official endorsement should be inferred.

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FOREWORD

How can schools provide individualized educational programs that adapt to the needs of each individual learner? This question, a continuing concern of practicing educators, has been a major focus of the work of the Learning Research and Development Center for a number of years. With the passage of the Education For All Handicapped Children Act, PL 94-142, and the resulting push to mainstream exceptional children, this topic is now receiving increased attention in most of the nation's schools. As a result, many school systems are attempting to develop classroom procedures for tailoring instruction to the needs of each student. The article presented here, "Adaptive Instruction: Building on Diversity" by Margaret Wang, is being made available through LRDC's Reports to Educators series because of the timeliness of the topic and, more specifically, as a result of the interest in the procedures described here that was evidenced in a conference on this topic held at the Center in May of 1980. In this report, Dr. Wang describes an approach to adaptive instruction which has been developed at the Center and which is currently being used in a number of school systems throughout the nation.

C. Mauritz Lindvall, Series Editor
Director, School Relations Project
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Adaptive Instruction: Building on Diversity

Developing ways to adapt school learning experiences to individual differences in students has long been a concern for educational researchers and practitioners. Research literature on both the extent of variation among students and the need for adapting school instruction to individual differences in students goes back well over 100 years (e.g., work cited in Washburne, 1925). This recognition has resulted in sustained and growing interest in developing educational programs and instructional technologies that adapt school learning to the different abilities, experiences, interests, and socio-economic backgrounds of children. The advances that have been made during the past decade in building theories and instructional practices have greatly increased our capabilities for providing a range of alternative learning environments to accommodate the wide range of student needs. Instructional programs such as PLAN (Flanagan, 1970), IGE (Klausmeir, 1972), IPI (Lindvall & Bolvin, 1967), and PEP (Wang & Resnick, 1978) have demonstrated the feasibility of having children work at widely varying academic levels within the same classroom.

The general concept of adaptive instruction, that is, the use of alternative instructional strategies and resources to meet the learning needs of individual students, has now become widely accepted.

This acceptance may be attributed to (a) demonstrations of the feasibility of creating classroom learning environments where adaptive instruction can be effectively implemented, and/or (b) current movements by the general public and judicial and legislative mandates that place increasing demands on schools to provide equal educational opportunities for all children. Whatever the reason, many school districts, regardless of the particular curricular materials used, now attempt to assess individual capabilities and to match instruction, as directly as possible, to those assessments. While skill at, and technical assistance for such efforts are only now being widely developed, school districts are receptive to the instructional approaches that are tied to direct assessment of student capabilities and to building the individual student's competence.

Providing adaptive instruction requires that alternate means of instruction are matched to students on the basis of knowledge about each individual's background, talents, interests, and past performance. An individual child's abilities and styles are assessed, both upon entrance to and during the course of learning, and the information obtained is used in selecting subsequent alternate learning opportunities. This educational process also attempts to bring students' abilities into a range of competence that enhances their capability to profit from the available instructional alternatives. The concept of adaptive instruction is built upon the assumption that as a consequence of such an educational approach, wider ranges of abilities can be accommodated and capabilities for learning and motivation can be developed and utilized (c.f., Glaser, 1977).

The positive effects of featuring adaptive instruction as an alternate approach to achieving the goal of equal educational opportunities for all children, particularly in the context of mainstreaming exceptional children into regular classroom settings, have been suggested in many recent reports (e.g., Pizzo, 197[illegible]; Consilio, 1974; Reynolds & Birch, 1977; Wang, 1979). When the instructional program is designed to accommodate the individual differences of all students in the class, differences in the placement and learning progress of individual students are expected and even assumed by the teacher, students, and parents. In such classes no special labeling is needed to differentiate one child from another, and momentary problems in learning are not viewed as failures, but as occasions for further teaching. Consequently, all children should be able to receive instruction suited to their needs without the negative effects of being specially labeled or of being socially and educationally segregated.

While the potential value of providing adaptive instruction is widely recognized, practical problems in implementing adaptive instruction in classroom settings do exist. Adapting instruction to student differences places considerable strain on the teacher's time, as well as the teacher's skills in diagnosing and making curricular decisions, reorganizing and restructuring the classroom environment, and managing the classroom processes. Therefore, effective implementation of adaptive instruction will require some fundamental changes not only in the nature and the structure of the curricular materials but also in school organizational patterns, the teaching and learning processes, and in teacher and student roles. The purpose of this paper is to discuss some of these changes by describing the essential characteristics of adaptive instructional programs.

Because of space limitations, the nature and the structure of the curricular materials required for effective implementation of adaptive instruction will not be discussed. These topics have been dealt with extensively elsewhere (e.g., Lindvall & Bolvin, 1967; Bolvin, 1968; Glaser, 1977; Talmadge, 1975). The focus of this paper will be on programming and classroom management support requirements for the implementation of adaptive instruction in classroom settings.

SOME SALIENT CHARACTERISTICS OF ADAPTIVE INSTRUCTION

Several programming and classroom management supports have been identified as essential to the effective implementation of any truly adaptive educational program. These include the diagnosis and monitoring of student learning progress, the teaching of self-management skills, and organizational supports such as multi-age grouping and team teaching.

Diagnosis and Monitoring of Student Learning Progress

Diagnosing and monitoring student learning progress has become an operating feature of programs aimed at adapting instruction to student differences. A key component of such programs is the use of criterion-referenced assessment indices as a means of matching instruction to the learning needs of individual children. Criterion-referenced assessments, that is, indices designed to determine the presence or absence of certain specific competencies, provide teachers with the necessary information to determine skills and knowledge already possessed by students so that their appropriate entrance into the learning sequence can be insured. Furthermore, the use of such clear-cut descriptions of the students' capabilities insures that they neither repeat tasks that they have already mastered nor work on objectives for which they lack critical prerequisites. Such process-oriented assessments for diagnosing and monitoring student learning are likely to result in the kind of optimization of instruction which adaptive instruction is designed to achieve.

Testing, however, cannot serve its purpose without an efficient record-keeping system to maintain accurate and up-to-date information about student learning. A systematic record-keeping system must be designed in such a way that it makes minimal demands on the teacher's time and provides critical information about each student's learning. Information such as students' short- and long-term learning histories, based on accumulated student progress information (e.g., whether there are specific types of learning tasks that tend to require more learning time for a particular student), is critical for providing the best match between instructional alternatives and the individual student.

Paper-and-pencil, as well as computerized record-keeping systems, have been adopted by teachers using some form of adaptive instruction. While paper-and-pencil systems are useful in collecting and maintaining a minimum set of student learning information for short-term instructional planning, a computerized system can provide a more comprehensive information recording and retrieval system. With rapid advances being made in computer technology, and the availability of micro-computer systems that are economically feasible for school use, the utilization of a computerized information management system could be considered an operating feature of adaptive instruction. A workable computerized system should include (a) a simple recording scheme that can be easily followed by students in the elementary grades, (b) a built-in checking scheme to insure the accuracy of the data recorded, (c) a simple retrieval scheme that permits young children and teachers to obtain up-to-date information on student learning progress, and (d) a clear display of information on the instructional optious that are available to a given individual student with certain learning characteristics (Wang & Fitzhugh, 1978). It is important to point out, however, that while using the computer as a tool for recording and analyzing student progress data can greatly enhance the teacher's capability in providing adaptive instruction, adaptive instruction can be effectively implemented without the use of a computer.

The Teaching of Self-Management Skills

The relationship between academic performance and self-management behavior has received increasing attention by social psychologists and educational researchers in recent years (e.g., Andrews & Debus, 1978; Bandura, Adams, & Beyer, 1977; Clifford & Cleary, 1972; Davis & Phares, 1967; DeCharms, 1972; Hisawa, 1976; Phares, 1968; Pines & Julian, 1972). Research results suggest that students who are high in self-management appear to make much more use of previously learned concepts and principles in problem solving than those who are low in this skill. Students who possess self-management skills also tend to display greater persistence in actively seeking information relevant to arriving at a solution to those problems. Furthermore, research results indicate that when children are taught self-management skills, their classroom behavior tends to become more independent and their task completion rates increase significantly.

It is important to note that children need to be taught the self-management skills for planning and carrying out learning plans with increasing independence, just as they need to be taught to read. It should not be assumed that self-management skills develop with maturity. Children need to be taught how to search for useful information and to order and organize this information for learning and retention. The development of these skills is viewed to be as "basic" as the three R's to children's effective functioning in learning environments where the adaptive approach to instruction is implemented. An essential characteristic of adaptive instruction is the student's active involvement in the instructional-learning processes and the resulting acquisition of increased competence in self-directed learning. Student self-responsibility for planning and carrying out learning activities is not only integral to the process of adaptive instruction, it is also an expected outcome of adaptive instruction.

Organizational Supports

Implementation of any innovative school program depends not only upon the acceptance and cooperation of teachers, administrators, parents, and children, but also on the availability of organizational supports. A common feature of successful programs is the availability of systematic procedures for the utilization of supports for program implementation and operation. In fact, one of the reasons for unsuccessful implementation of innovative practices in schools has been the lack of well-defined operational supports (e.g., Anderson, 1973; Conner, 1976; Decker & Decker, 1977).

The implementation of adaptive instruction requires training teachers to effectively utilize available support systems to meet the wide range of student needs. Teachers using the adaptive instructional approach are challenged to become resourceful in managing the more flexible and diverse learning alternatives that must be made available. Professional help from other teachers and education personnel, for example, should be viewed as an integral and necessary support system in order to meet the demands adaptive instruction is likely to place on the teacher. Perhaps more importantly, successful classroom implementation of adaptive instruction requires some organizational changes that can facilitate the more effective utilization of available resources. Multi-age grouping and team teaching are examples of such organizational supports.

Multi-age grouping. Adapting school learning experiences to children of diverse learning characteristics requires some built-in flexibilities not only in the instructional-learning process but also in classroom organization patterns. These include providing for flexible use of space, time, and learning resources by students and teachers. One way to achieve this flexibility is through a multi-age grouping or ungraded classroom design. This type of classroom organization is likely to be more effective in accommodating students who make unusually slow or unusually fast progress. The ungraded classroom organization allows for deceleration or acceleration of schooling commensurate with individual requirements without conspicuous failures.

Repeating or skipping a grade rarely solves a child's learning problems. Children who are held back after not being able to keep up with students of the same age are likely to consider themselves failures. A feeling of failure only adds to their sense of inadequacy and their poor self-concept. Such feelings of inadequacy are unlikely to be generated if these children are able and encouraged to succeed at their own rates and levels in a multi-age setting. What "slower" children need is an opportunity to learn at a pace that is adaptive to their own learning needs, with more individual help from the teacher and/or their peers. Since ungraded classes take into account the individual differences and different rates of progress among all students, exceptional children do not have to measure up to their age-peers or suffer the consequences of repeating or skipping a given grade. In addition, multi-age grouping permits teachers to spend more time with extremely immature, vulnerable, or talented children. These children can therefore be given special attention before they develop serious learning and behavioral problems that would require extensive remedial work.

Multi-age grouping is also an important program design feature from the perspective of the effective use of teacher time. For example, if a class includes both first and second graders, the teacher need not spend as much concentrated time on reading as he or she would with a class of all first graders. Since only half the children will likely be nonreaders, the teacher may not need to provide as much intensive instructional time for everyone. Although all children will need some instructional time, the students who have passed beyond the beginning reading stage can benefit from some independent reading activities while the teacher works with the nonreaders.

A less obvious benefit of multi-age grouping is the opportunity for both spontaneous and planned peer modeling and peer tutoring. Peer modeling and peer tutoring are thought to help the academic and social development of both the tutor and tutee (Allen, 1976). In addition to the socialization functions that have been attributed to peer groups in the literature (e.g., Lippit, 1976), cross-age tutoring situations seem to contribute to the school achievement and achievement motivation of both tutors and tutees. In fact, with the multi-age grouping practice, students, with their individual strengths, are expected to serve as important social and academic resources for each other.

Team teaching. Team teaching is another viable strategy for increasing the flexibility required in order to meet a wide range of student needs. The main advantage of team teaching is the flexibility it provides in allocating teacher resources to more effectively meet the needs of the individual student. It also provides the possibility of using alternative grouping methods. Further, team teaching has the potential of using the interests and talents of teachers to the fullest extent. Research in this area has found a higher level of job satisfaction among teachers in team-teaching situations as compared to teachers in self-contained situations (Charters, 1978).

Team teaching has several other positive effects on both teachers and students. From the teacher's perspective, team teaching is associated with a greater desire for collegial evaluation and an increased sense of influence and autonomy in making decisions about school and classroom matters. It also allows for a wider range of instructional styles and provides flexibility in scheduling. Students in team-teaching classrooms have been found to tend to spend more of their school time receiving instruction than those in self-contained classrooms (e.g., Cohen, 1976; Schmuck, Paddock, & Packard, 1977). Studies investigating the effects of team teaching also suggest that team teaching makes possible the provision of more learning alternatives to students and results in significant differences in student achievement as well as in students' self-concepts and attitudes toward school. One of the more intangible effects of team teaching on both teachers and students has to do with its role in promoting closer teacher-student relationships (e.g., Adams, 1962; Cohen & Bredo, 1975; Cohen, Deal, Meyer, & Scott, 1976; Dawson & Linstrom, 1974).

Family Involvement

Research literature indicates that a major source of a child's patterns and/or motives for achievement is the home environment. The behavior and attitudes of the family, as well as the nature of the physical setting, have a direct impact on a child's behavior before and during the school years. As pointed out by Bronfenbrenner (1974), after reviewing various early intervention programs, educational interventions without family involvement are not likely to be successful. Education includes processes within the family as well as those that occur in the schools. That is, learning involves the combination of the home and school environments.

A typical strategy for family intervention is to teach family members how to teach the child or how to interact with the child around some cognitive activities (e.g., Gordon, 1977). The specific family involvement activities in a program may not be as important as the goals of the program. Family involvement can take a variety of forms. At the minimum, it should involve awareness activities to insure that the family is knowledgeable about the child's learning plans, the school curriculum, and the child's progress within the curriculum. The goal is to increase communication between home and school in order to help meet the learning needs of the child.

A BRIEF OVERVIEW OF AN ADAPTIVE INSTRUCTION PROGRAM THAT WORKS

The general principles presented in the foregoing discussion will probably take on more meaning if an illustration of how they can be applied to an actual school situation is provided. The Adaptive Learning Environments Program developed at the University of Pittsburgh's Learning Research and Development Center is described here to provide such an illustration. The overall goal of the Adaptive Learning Environments Program is to provide effective school environments that maximize the outcomes of learning for individual children--environments where each child can effectively master basic skills in academic subjects, such as reading and mathematics, while becoming confident in his or her ability to learn and to cope with the social and physical classroom surroundings. Basically, the program design represents an attempt to combine aspects of prescriptive instruction that appear to be effective in assuring basic skills mastery with aspects of informal education that appear to be useful in generating attitudes and processes of inquiry, self-dependence, and social cooperation. In this approach to instructional management, schools are viewed as social systems which respond effectively to individual differences and shape such personal and social student outcomes as: positive self-perceptions of one's academic and social competencies, a sense of responsibility to the school and the broader social community, and the competency needed for independence and autonomy in learning.

Specifically, the Adaptive Learning Environments Program includes (a) a prescriptive learning component made up of a series of highly structured and hierarchically organized curricula for basic skills development; (b) a more open-ended exploratory learning component that includes a variety of activities designed to adapt to student interests and needs as well as the constraints of classroom physical space and other school resources; (c) systematic classroom management procedures to facilitate effective implementation of both the prescriptive and the exploratory components, and a classroom organization plan that maximizes the use of available classroom and school resources (i.e., curricular supports as well as students' and teachers' time); (d) a family involvement program that attempts to reinforce the integration of school and home experiences; and (e) a multi-age and team-teaching organization to increase flexibility in the use of teacher, student, and time resources.

In classrooms implementing the Adaptive Learning Environments Program, children can be found working in virtually every area of the room at any given time, with the teacher circulating among them. Basic skills are taught directly, and children are expected to learn. If one of them does not, it is not viewed as the child's failure, but rather a signal or challenge to the teacher to try other instructional alternatives. Because learning tasks are broken down into small steps, there are frequent opportunities for evaluation, so that many small successes can be recognized and acknowledged, and momentary difficulties can be pinpointed before they become learning problems.

Through an instructional-learning management system, called the Self-Schedule System (Wang, 1974), children are taught to plan their own schedules so as to ensure that both their assigned and their self-selected tasks are correctly completed within the time limits they and the teacher have specified (e.g., half a day, one day, one week). During any given school day, students are generally responsible for completing all the tasks prescribed by the teacher for the various prescriptive learning curricula and at least two or more learning activities of their own choice. Exceptions may occur when the teacher designates a specific time for small group instruction, diagnostic testing, or group instruction classes in music, physical education, art, and library. In addition, classroom activities, such as special group and individual projects or tutoring sessions with teachers, may also be scheduled for students who have difficulties with specific learning tasks or for those who are particularly interested and/or talented in certain curricular areas.

For the past decade, the components of the Adaptive Learning Environments Program have been in operation in hundreds of classrooms across a wide range of geographic regions. Results produced by the program in terms of student academic achievement have been positive (e.g., Wang, Resnick, & Scheutz, 1974; Resnick, Wang & Rosner, 1977; Wang, 1979). Perhaps of even greater interest and meaning are the data on classroom processes observed when the program is in operation. For example, students were found to spend, on the average, about 35 percent of their time working independently on individual tasks (either assigned by teachers or self-selected) and about 65 percent of their time working in small or large group settings (Wang, 1974). They spent about 74 percent of their time completing teacher-assigned prescriptive learning activities and 15 percent of their time completing exploratory learning tasks of their own choice. They were observed to be "on task" 70 percent of the time. This rate of observed on-task behavior is quite high in comparison to the statistics reported from some of the nationwide studies of classroom processes (e.g., Berliner et al., 1978). Students were found generally to be able to complete all of the assigned tasks and more. In fact, results from one study designed to investigate the effects of the program on low- and high-achieving students show that the average task completion rate for students in this particular classroom was 105 percent. (This figure reflects the fact that students in classrooms where the program is implemented generally finish more tasks than they are expected to complete.) No significant differences were ascertained in the task completion rates of high- and low-achieving students, nor were differences found in the two groups for such classroom process variables as on-task behavior patterns, interactions with peers, and student self-perceptions of their own competence in managing their own learning (Wang, 1979).

DISCUSSION

The implications for using an adaptive instructional approach, such as the Adaptive Learning Environments Program, to meet the mandate of providing quality education for every child seem far-reaching, particularly in the context of the popular public sentiment to go "back to basics." The Adaptive Learning Environments Program is designed with the assumption that one does not need to trade off the systematic teaching of basic skills in order to gain programming flexibility or foster student involvement in planning, making curricular choices, and self-evaluating learning progress. One can achieve both types of outcomes, and both are "basic" in today's education. The three R's are important but not sufficient to prepare every child to gain access to equal life chances. However, it is also important to note that in the Adaptive Learning Environments Program discussed in this paper, the "basics" include a broad spectrum of subject matters, such as science, social studies, physical education, music, art, drama, oral communication, and consumer education, as well as an understanding of the democratic way of life, and an understanding of other cultures. The "basics" are also meant to develop personal discipline, a sense of self-efficacy, and the ability to adapt in a changing world.

"Basic" education today must be viewed as more than re-adopting the McGuffey Readers, memorizing the multiplication tables, and putting chairs in the classroom back into straight rows. Perhaps one of the most serious dangers of going "back to basics" is the curtailing of variety in the curriculum. Effective implementation of the type of adaptive instructional approach described in this paper enhances the acquisition of a wide range of skills, including basic skills in the three R's. More importantly, the adaptive instructional approach assumes that students learn in different ways and need various kinds of organizational structures and instructional techniques at different stages of their development if they are to achieve mastery of essential skills and knowledge and also develop those attitudes and perceptions that will enable them to be lifelong learners.

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Appendix

Listing of Performance Indicators in Each Critical Program Dimension of the Adaptive Learning Environments Model (ALEM)

Critical Dimensions	Performance Indicators
Arranging Space and Facilities (AS&F)	Furniture/learning centers are arranged in such a way that students and teachers can move about with ease.
	There are signs that clearly label the separate learning areas.
	There is a system controlling the numbers of students and the movement among different activity areas.
	There is a clock or some method students can use to keep track of the time.
	Sufficient teacher call signals are available in work areas for prescriptive, as well as exploratory, learning activities.
	There is a separate area for the teacher to work with individual students (e.g., tutoring, testing).
	An area for storage and display of learning materials for each component of the curriculum is clearly labeled, demarcated, and accessible to students.
	The location of storage/display areas encourages appropriate integration of materials within a curricular area.
	To the extent possible, student work space in each storage and display area is located conveniently according to activity type.
	There is adequate work space for individual and group activities and independent work.
	Each student has an individual place for his or her personal belongings.
	Students' completed work is on display.
	Prescriptive learning materials are arranged in sequential order and marked with an easily deciphered identification code.
	Materials are categorized to facilitate selection and replacement by students.
	Records, tapes, and similar items are labeled with pictures and/or words that are intelligible to students with limited reading abilities.
Creating and Maintaining Instructional Materials (CMIM)	Equipment/materials are neat, durable, and in usable condition and sufficient supply for carrying out activities.
	Materials are interesting and attractive to students.
	There is at least one learning task for each curricular objective.
	There is an up-to-date list of learning tasks for each curricular objective.
	Alternative prescriptive learning materials are available in the room.
	There is a sufficient variety of activities to accommodate student differences and allow students a choice.
	In each exploratory learning center, there are at least two or three activities that vary in content and level of difficulty.
	Some activities are designed to encourage social interaction.
	Teacher-constructed learning tasks are related to specific curricular objectives.
	Teacher-constructed learning tasks are accompanied by a list of materials and a script of directions.
	Directions/statements/questions on scripts for teacher-constructed learning tasks relate to, and are consistent with, curricular objectives and they are understandable to students.
	The teacher changes exploratory materials at least once a month, when a new unit of instruction is introduced, or when students no longer need/use materials.
Establishing and Communicating Rules and Procedures (ECRP)	The self-schedule form shows the teacher's expectations and the amount of work completed for a given day and for the week.
	Students regularly select at least two exploratory activities.
	Students complete prescribed activities within the specified time periods.

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(ECRP) continued	The number of students working in each activity area is in accordance with the specified limits.
	Students obtain adult help by using teacher call signals rather than by raising their hands.
	Students finish one task and ask the teacher to check work before starting another, except when waiting for teacher assistance.
	Students know when they may do their prescriptive work.
	Students know when they may do their exploratory work.
	Students know what to do when they need help with their work.
	Students know of any times during the day when activity areas are restricted.
	Students know what things in the activity area cannot be used without the teacher's help.
	Students know the consequences of not completing work.
	Students know what happens if they finish their work ahead of schedule.
	Students help out in the classroom by performing tasks such as cleaning paintbrushes and watering plants.
	Students state whether other students helped out in the classroom.
Managing Aides (MA)	A time is established for exchanging information with aides daily.
	The established time for exchanging information with aides includes assignment of the aides' duties.
	The teacher discusses the performance of individual students with aides.
Record Keeping (RK)	All classroom records are neat, up-to-date, and accessible.
	Student progress wall charts for the various curricular activities are complete.
	There is an up-to-date record of the prescriptive tasks completed by each student in each curricular area.
Diagnostic Testing (TEST)	The teacher gives placement tests when students enter each curricular area or when he or she feels a re-evaluation is necessary.
	The teacher gives pretests at the beginning of each unit of instruction.
	The teacher gives posttests at the end of each unit of instruction.
	The teacher gives placement tests to determine appropriate instructional levels for transfer students.
Prescribing (PRES)	Students work in different units within each of the prescriptive curricula.
	If a student is given additional work for a curricular objective, different tasks or pages, rather than the same tasks, are prescribed.
	Prescriptions are related to diagnostic test results.
	Prescriptions include the number of tasks and/or workbook pages to be completed.
	Prescriptions follow the sequence recommended for each curricular area.
	The teacher varies prescriptions (task and amount of work) to meet the needs of individual students.
	When appropriate, the teacher re-structures specific learning tasks for students.
Monitoring and Diagnosing (M&D)	Most students pass at least one posttest in each curricular area each month.
	The teacher checks work in students' presence and interacts with students about the work.
	The teacher determines the sources of difficulty for the completion of tasks by individual students.
	The teacher helps students complete work on time.
	The teacher discusses with students their work plans and/or their progress toward completion of their work.
	The teacher is aware of the reading and math levels in which each student is working.
	The teacher is aware of each student's preference for particular curricula.
	The teacher changes prescriptions, or writes new prescriptions, when traveling.
	The teacher discusses students' performance with their parents.

(M&D) continued	The teacher discusses students' performance with other relevant instructional staff.
Interactive Teaching (IT)	The teacher spends short periods of time with each student.
	The teacher responds to those students who signal properly.
	The traveling route, an established pattern, includes all areas in which students are working.
	The teacher looks around the room (scans) after each student contact.
	The teacher notices and acknowledges each student who requests/needs help.
	The teacher encourages students to help each other with their work (peer tutoring).
Instructing (INST)	The teacher helps students structure learning tasks and communicates the procedures required for performing the tasks.
	The teacher communicates to students the criteria for successful performance.
	The teacher uses questioning.
	The teacher uses explaining.
	The teacher uses cueing or prompting.
	The teacher uses demonstrating.
	The teacher uses modeling.
	The teacher interacts with students concerning the content of specific tasks/assignments.
	The teacher's questioning techniques encourage extended student responses.
	The teacher uses small-group instruction as part of prescribed activities.
	The teacher forms small groups of students on the basis of diagnosed needs.
	The teacher conducts math maintenance drills at least twice a week.
	The teacher groups students for supplementary instruction.
Motivating (MOTI)	The teacher shows personal regard for each student.
	The teacher gives praise when appropriate.
	The teacher encourages self-management.
	In contacts with students working on exploratory activities, the teacher shows an interest in student work.
	The teacher's words and behavior communicate that students are expected to succeed.
Developing Student Self-Responsibility (DSSR)	Students readily locate prescriptions.
	When waiting for teacher assistance, students are occupied with other curricula-related tasks or constructive interactions with other students.
	Students readily locate materials and equipment for all tasks.
	Students use learning materials and equipment appropriately.
	Students return materials and equipment to the correct places and clean up their work places when tasks are completed.
	After their completed work is checked, students put it in a designated place.
	Each student knows how to use his or her own prescription.
	Each student knows how to use his or her self-schedule form.
	Students know how many assignments they have to finish on any given day.
	Students know how many tasks they have left to finish.
	Students know the deadlines for completion of tasks.
	At least 80% of the students in the classroom have demonstrated some gains in self-management skills.
	At least 50% of the students in the classroom are working in the self-scheduling Objective designated as appropriate for the particular time of the school year.

This appendix is taken from Wang, M.C., Catalano, R., and Butcher, M.S. Training Manual for the Implementation Assessment Battery for Adaptive Instruction. Pittsburgh, PA.: University of Pittsburgh, Learning Research and Development Center, 1983.

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